Garney Construction

785 E Warren
Gardner, KS 66030

Phone: 816-278-5950
Fax: 816-278-5931

SUBMITTAL ITEM NO. 26 13 23-001
PACKAGE NO: BP4 Reyn

TITLE: 4b Medium Voltage Metal Encl SWGR
PROJECT: Ward County Pump Station Project
DRAWING:
STATUS: OPN
BIC: FNI

REQUIRED START:
REQUIRED FINISH:
DAYS HELD: 0
DAYS ELAPSED: 1
DAYS OVERDUE: 0

RECEIVED FROM		SENT TO		RETURNED BY		FORWARDED TO	
RC	SS	FNI	NL	FNI	NL	RC	SS

Revision No.	Description / Remarks	Received	Sent	Returned	Forwarded	Status	Sepias	Prints	Drawing Date	Held	Elapsed
001	BP 4b Medium Voltage Metal Enclosed Switchgear Urgent Submittal - Garney and FNI will review concurrently	2/27/2012	2/28/2012			OPN	0	1		0	1

Garney Construction

Ward County Pump Station Project

Submittal No. 26 13 23-001

This submittal has been reviewed and approved with respect to the contract documents and specification section BP4 Reyn

Approval or acceptance of the submittal does not relieve the vendor of their responsibility to comply with the contract documents.

Supplier/Sub: RC

Date: 2-28-12 **Reviewed by:** Marcus Grace

Rockwell Automation Transmittal – Approval Drawings/Documentation

Date: February 19, 2012

To: **Rockwell Automation**
2304 Tarpley Road
Carrollton, Texas, USA
75006
972 417 5400

Attention: Kevin Nowak

Subject/Project: TRANSMISSION PUMP STATION
Customer: WARD COUNTY WATER SUPPLY

Distributor: THE REYNOLDS COMPANY
Distributor PO#: 1638098-00

Return Due Date: March 9, 2012
Scheduled Ship Date: August 27, 2012

RA Order#: 7012576 **Item(s):** 001 to 008

These approval drawing(s) / documentation are submitted for equipment and final scope approval before engineering can be finalized, at which time manufacturing will commence. Any requested changes may be subject to additional charges based on scope, and possible delays in shipment.

Please review and return these drawings by the due date as listed above so that we may proceed with manufacturing. If the drawings are not received by the deadline specified above, the reserved engineering and manufacturing times and scheduled ship date may be lost. The order will then be re-scheduled, upon the receipt of the drawings, using the next available time slots in each area. We reserve the right to revise the ship date based on changes and/or additions to the approval drawings

Please ensure the returned drawings are clearly tagged with one of the following drawing codes.

> **Code A - Proceed with manufacturing along with any noted changes**. Information drawing(s) / documentation will be submitted once engineering is finalized. Information drawing(s) / documentation are not intended to be used as re-approval of drawings and/or equipment scope.
>
> **Code B - Do not proceed with manufacturing and submit for re-approval.** Submittal of re-approval drawings requires an additional 4-6 weeks. This may delay the project an additional 4-6 weeks or more.

Please ensure that the appropriately tagged drawings are returned to:
Richard Yang: rdyang@ra.rockwell.com

Submittal Documentation
Medium Voltage Equipment
TPSSWGR

Ward County Water Supply

Transmission Pump Station

RA Order #: 7012576

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Publication: 7012576 – February 2012

Rockwell Automation

Submittal Documentation
Medium Voltage Equipment
TPSSWGR
Ward County Water Supply
Transmission Pump Station

RA Order #: 7012576

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	400A Moulded Isolator Switch, Bolt-On	80154-544
	Vacuum Contactor, Mechanically Latched	80158-908
Tab 5	**MCC Technical Data**	
	Medium Voltage Motor Controllers Specification Guide	1500-SR020H-EN-P
	Medium Voltage Controllers Selection Guide	1500-SG001B-EN-P

Publication: 7012576 – February 2012

135 Dundas Street
Cambridge Ontario
Canada N1R 5X1
Tel. +1.519.581.7424
Fax. +1.519.740.9871

Ward County Water Supply –Transmission Pump Station

Rockwell Automation Order Number: 7012576

Subject: Comments and Clarifications for Spec Section 26 13 23 up to and including Addendum 3

Date: February 19, 2012

1.00 GENERAL

1.01 WORK INCLUDED

1.01.A-B Comply.

1.02 QUALITY ASSURANCE

1.02.A-D Comply.

1.03 SUBMITTALS

1.03.A.1 Comply.
1.03.A.2.a See current document.
1.03.A.2.b-c See Tab 3, 4.
1.03.A.2.d-g See Tab 1.
1.03.A.2.h-j See Tab 2.
1.03.A.2.k-l See Tab 5.
1.03.A.2.m See Tab 1.
1.03.A.2.n See Tab 5.
1.03.A.2.o See current document.
1.03.A.2.p See Tab 2.
1.03.A.2.q See Tab 1.
1.03.B-D Comply.
1.03.E NETA ATS is not within RA's scope of supply.
1.03.F-G Comply.

1.04 STANDARDS

1.04.- Acknowledged.

1.05 DELIVERY, STORAGE AND HANDLING

1.05.A-D Comply.
1.05.E RA standard 150W (120V) cabinet space heaters shall be provided.
1.05.F Comply.

1.06 COORDINATION

1.06.A-B Comply.

2.00 PRODUCTS

2.01 METAL ENCLOSED LOAD INTERRUPTER SWITCHGEAR

2.01.A-B.4 Comply.
2.01.B.5 The cable exit directions have been selected based on the Contract drawing.
2.01.B.6-12 Comply.
2.01.C-D Comply.

2.02 MISCELLANEOUS

2.02.A-H Comply.
2.02.I Not applicable.
2.02.J-L Comply.

3.00 EXECUTION

3.01 INSTALLATION

3.01.A-B Comply.

3.02 INSTALLATION

3.02.A Comply.

3.03 TESTING

3.03.A-J Comply.

3.04 TRAINING

3.04.A-F Comply.

3.05 FIELD QUALITY CONTROL

3.05.A-D Comply.

3.06 WARRANTY

3.06.A-C Comply.

3.07 CLEAN AND ADJUST

3.07.- Comply.

3.08 SPARE PARTS

3.08.A-F Comply. See Tab 3.

Please feel free to contact me directly regarding any technical issue or concern.

Sincerely,

Richard Yang, P.Eng
Application Engineer, MV Drives
Rockwell Automation Canada
Tel: +1.519.740.4100 ext. 2496
Email: rdyang@ra.rockwell.com

135 Dundas Street
Cambridge Ontario
Canada N1R 5X1
Tel. +1.519.581.7424
Fax. +1.519.740.9871

Ward County – Transmission Pump Station

Rockwell Automation Order Number: 7012576

Subject: TPSSWGR Warranty

Date: February 19, 2012

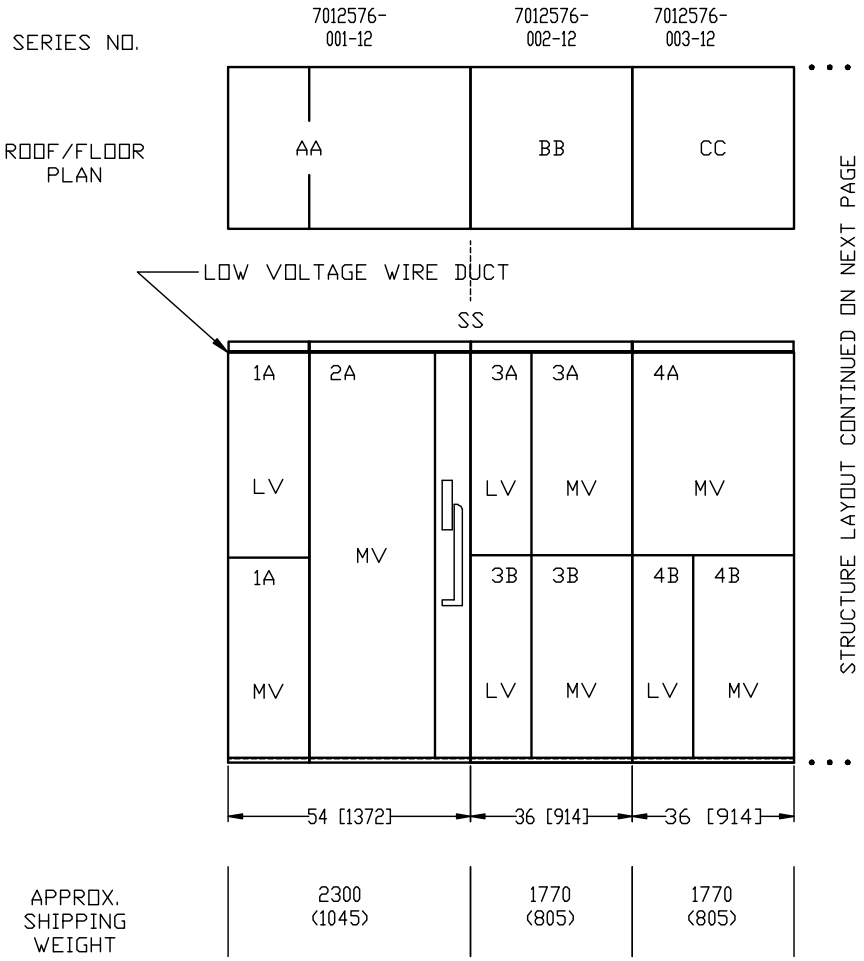
Rockwell Automation is providing the following warranty for TPSSWGR to be installed at the Ward County Transmission Pump Station:

Parts and Labor Warranty: (24) months following the installation, adjusting and acceptance testing, and the start of actual operation of the equipment, or (30) months from shipment, whichever occurs first.

Richard Yang, P.Eng
Rockwell Automation
Application Engineer – MV Drives
Ph: 519-740-4100 ext. 2496
Email: rdyang@ra.rockwell.com

STRUCTURE LAYOUT

TPSSWGR



TOTAL APPROXIMATE SHIPPING WEIGHT = 13450 (6114)

TOTAL WIDTH = 288 [7315]

WEIGHT = lb (kg)

LV = LOW VOLTAGE MV = MEDIUM VOLTAGE SS = SHIPPING SPLIT DIMENSIONS = in [mm]

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CUSTOMER	Colorado River MWD
DISTRIBUTOR	The Reynolds Company P.O. #1638107-00
PROJECT	WARD COUNTY WATER SUPPLY
ORDER NO.	
A-B ORDER NO.	7012576

LTR	REVISION	INT
1	ENG Program Approval 2012-02-21	PE

Allen-Bradley

DR.	P. Evans	DATE 2012-02-21
CERTIFIED	R. Yang	DATE 2012-02-21
SHEET 1	OF 13	

Rockwell Automation

DWG. NO. 7012576-001-12D

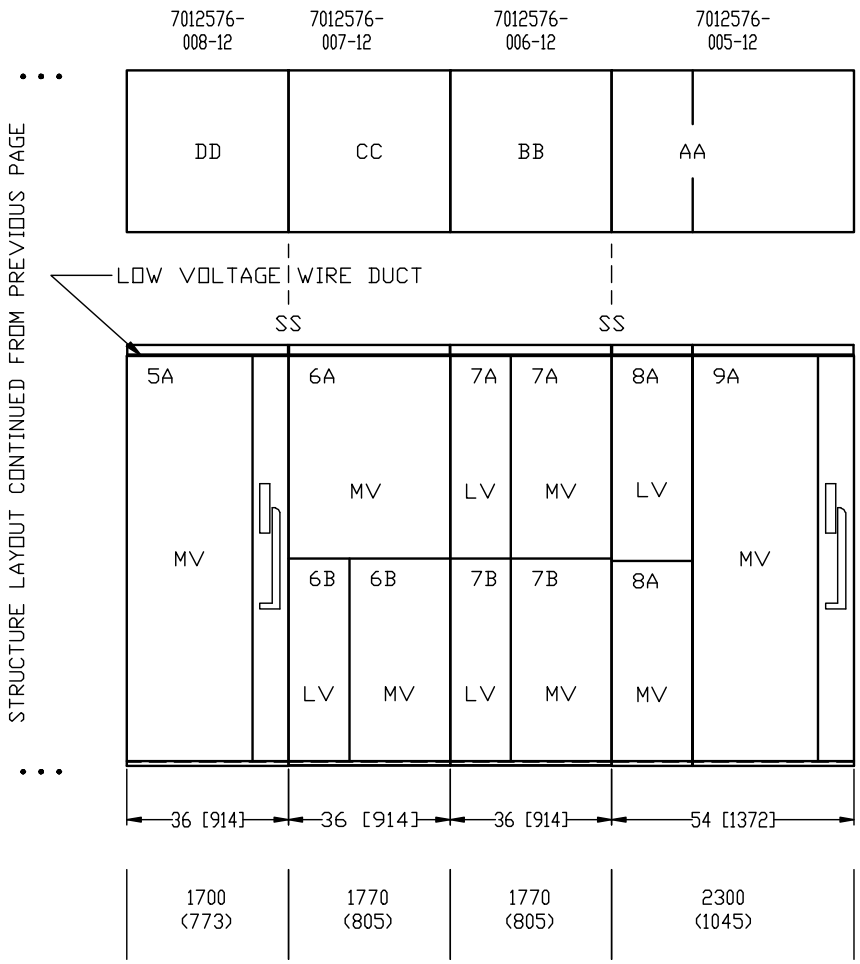
(J)

AutoCAD®

STRUCTURE LAYOUT

SERIES NO.

ROOF/FLOOR PLAN



APPROX. SHIPPING WEIGHT

1700 (773)	1770 (805)	1770 (805)	2300 (1045)

WEIGHT = lb (kg)

LV = LOW VOLTAGE MV = MEDIUM VOLTAGE SS = SHIPPING SPLIT DIMENSIONS = in [mm]

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CUSTOMER: Colorado River MWD

LTR	REVISION	INT
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Allen-Bradley

CERTIFIED: R. Yang DATE: 2012-02-21

SHEET 2 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

(J)

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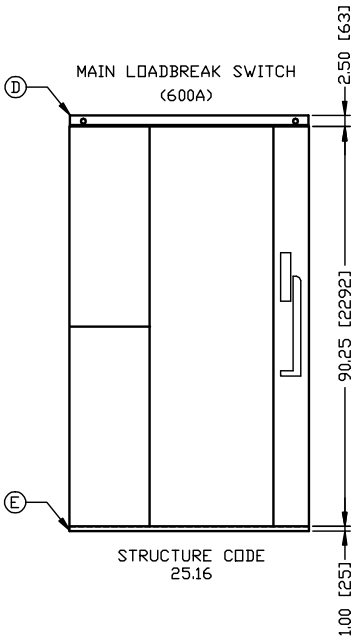
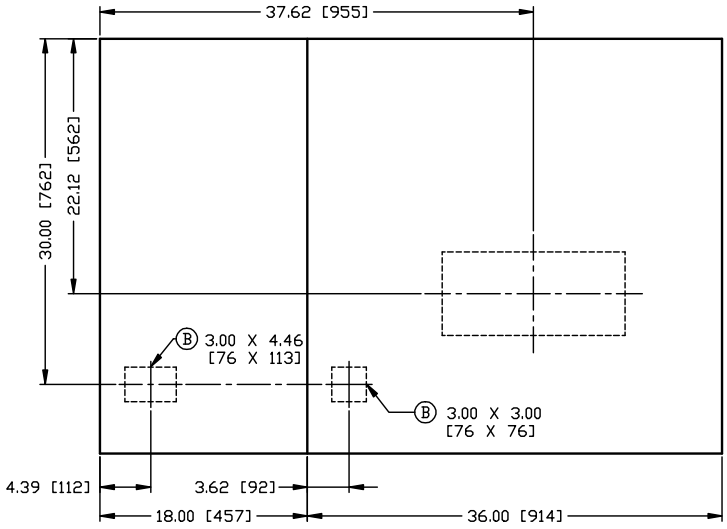
STRUCTURE DETAILS

PLAN LABELED "AA"



NOTE: CONTACT FACTORY FOR SEISMIC MOUNTING INFORMATION

ROOF PLAN



FRONT

Ⓐ LINE CABLE CONDUIT OPENING.

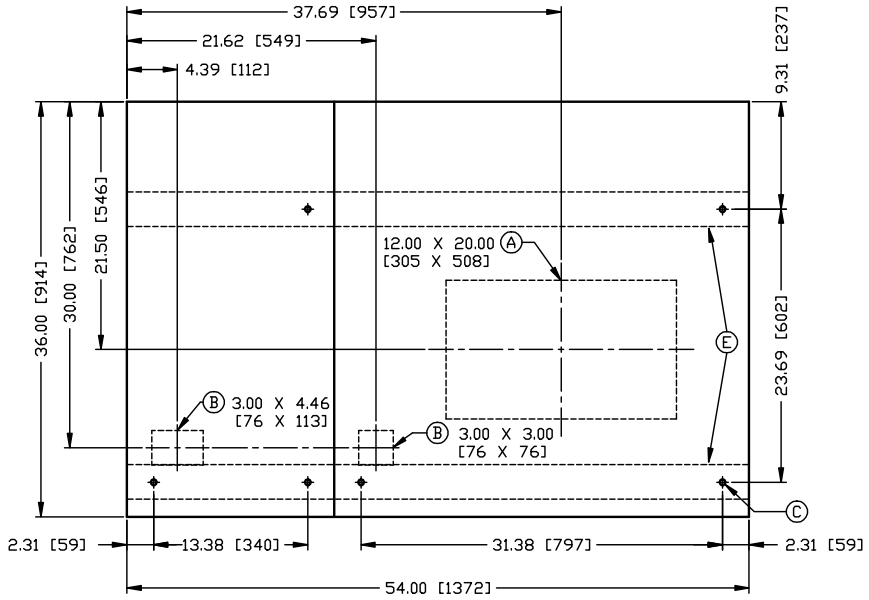
Ⓑ CONTROL WIRE CONDUIT OPENING.

Ⓒ MOUNTING HOLES FOR .50 [12] DIA. ANCHOR BOLTS.

Ⓓ REMOVABLE LIFTING ANGLES (2)

Ⓔ 1.00 [25] x 3.00 [76] NON-REMOVABLE SILL CHANNELS.

FLOOR PLAN



FRONT

DIMENSIONS = in [mm]

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CUSTOMER: Colorado River MWD

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Allen-Bradley

CERTIFIED: R. Yang

DATE: 2012-02-21

SHEET 3 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

(E)

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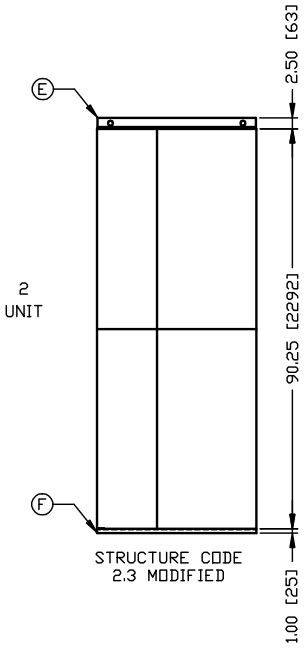
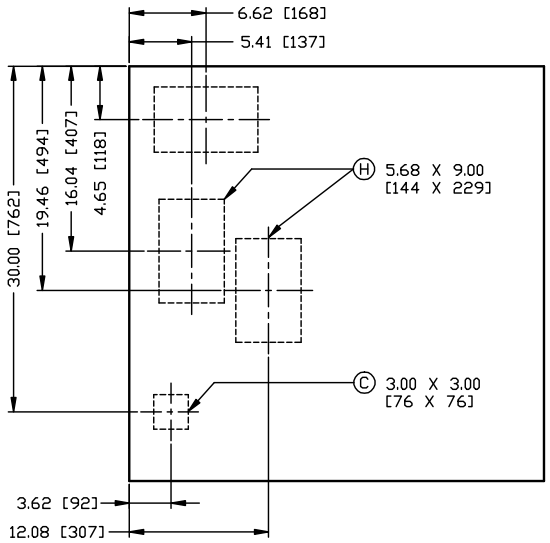
STRUCTURE DETAILS

PLAN LABELED "BB"



NOTE: CONTACT FACTORY FOR SEISMIC MOUNTING INFORMATION

ROOF PLAN



FRONT

Ⓒ CONTROL WIRE CONDUIT OPENING. EACH OPENING PROVIDES ACCESS TO BOTH TOP & BOTTOM COMPARTMENTS.

Ⓓ MOUNTING HOLES FOR .50 [12] DIA. ANCHOR BOLTS.

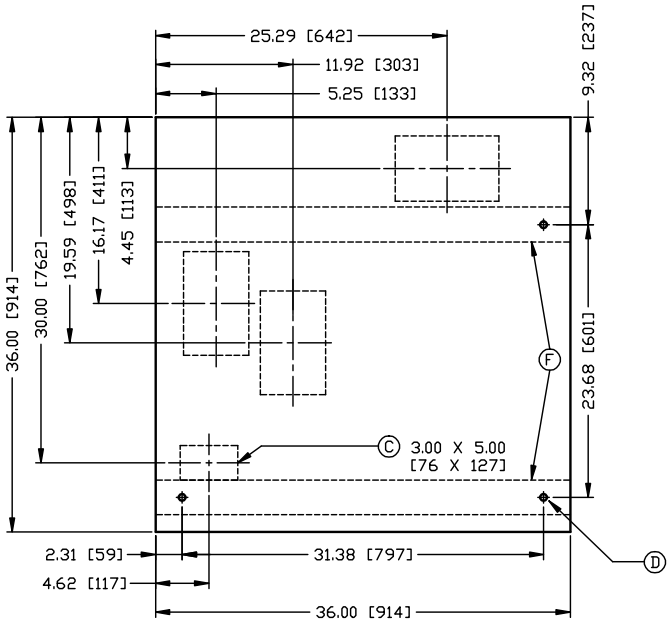
Ⓔ REMOVABLE LIFTING ANGLES (2)

Ⓕ 1.00 [25] x 3.00 [76] NON-REMOVABLE SILL CHANNELS.

Ⓗ TOP LOAD CABLE CONDUIT OPENING

DIMENSIONS = in [mm]

FLOOR PLAN



FRONT

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CUSTOMER: Colorado River MWD

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Allen-Bradley

CERTIFIED: R. Yang

DATE: 2012-02-21

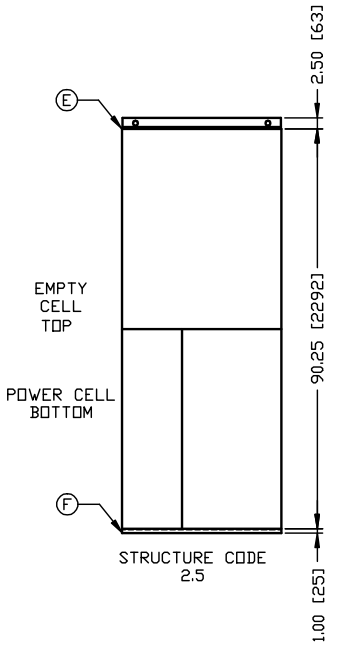
SHEET 4 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

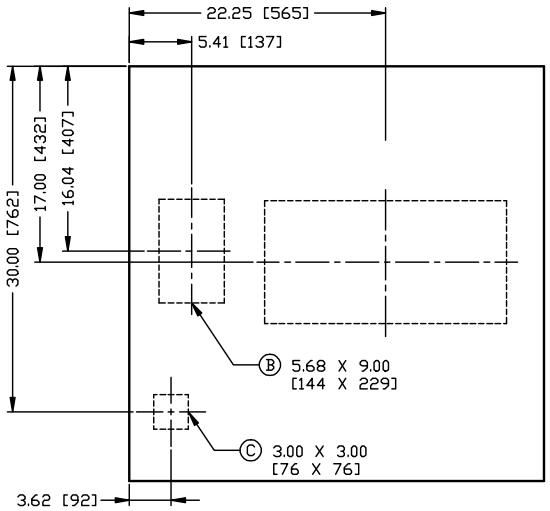
STRUCTURE DETAILS

PLAN LABELED "BB"



NOTE: CONTACT FACTORY FOR SEISMIC MOUNTING INFORMATION

ROOF PLAN



FRONT

Ⓑ LOAD CABLE CONDUIT OPENING FOR BOTTOM COMPARTMENT.

Ⓒ CONTROL WIRE CONDUIT OPENING.

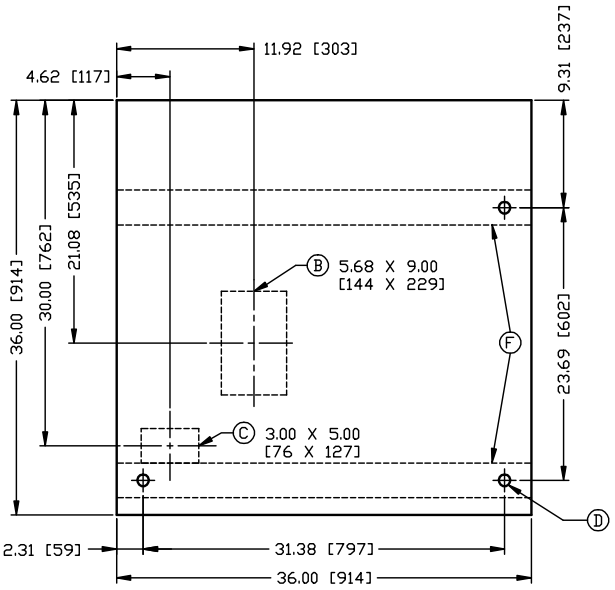
Ⓓ MOUNTING HOLES FOR .50 [12] DIA. ANCHOR BOLTS.

Ⓔ REMOVABLE LIFTING ANGLES (2)

Ⓕ 1.00 [25] x 3.00 [76] NON-REMOVABLE SILL CHANNELS.

DIMENSIONS = in [mm]

FLOOR PLAN



FRONT

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CUSTOMER: Colorado River MWD

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CERTIFIED: R. Yang

DATE: 2012-02-21

SHEET 5 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

(G)

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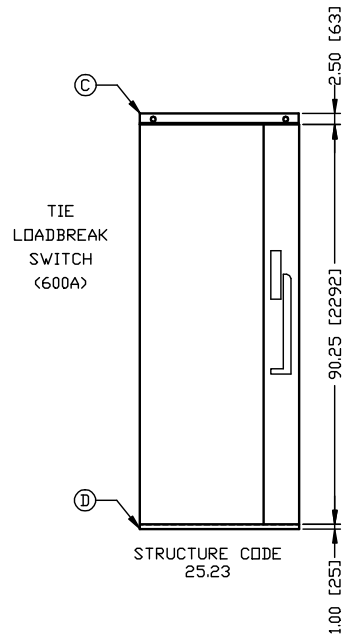
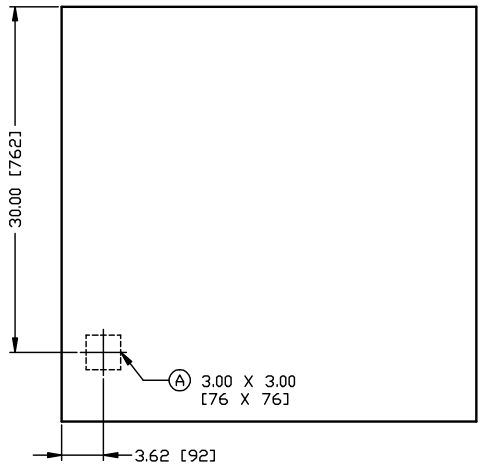
STRUCTURE DETAILS

PLAN LABELED "DD"



NOTE: CONTACT FACTORY FOR SEISMIC MOUNTING INFORMATION

ROOF PLAN



FRONT

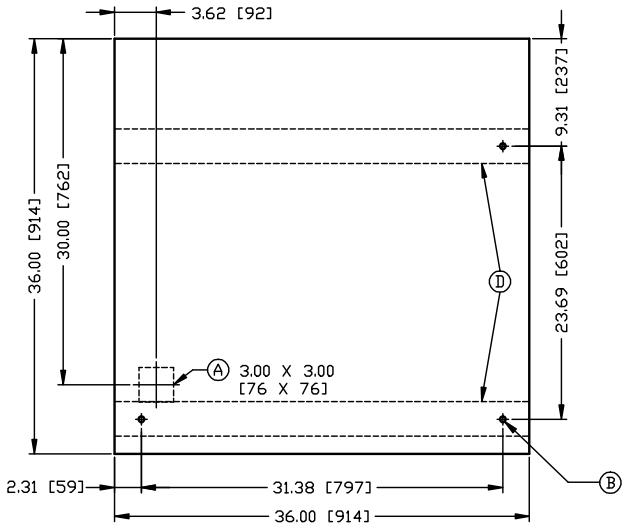
Ⓐ CONTROL WIRE CONDUIT OPENING.

Ⓑ MOUNTING HOLES FOR .50 [12] DIA. ANCHOR BOLTS.

Ⓒ REMOVABLE LIFTING ANGLES (2)

Ⓓ 1.00 [25] x 3.00 [76] NON-REMOVABLE SILL CHANNELS.

FLOOR PLAN



FRONT

DIMENSIONS = in [mm]

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CUSTOMER: Colorado River MWD

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Allen-Bradley

CERTIFIED: R. Yang

DATE: 2012-02-21

SHEET 6 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

(C)

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GENERAL INFORMATION

POWER SUPPLY	4160 **V** 3 **Ø** 60 **Hz**	**ALTITUDE**	0 - 1000 m / 0 - 3300 ft
CONTROL SUPPLY	120 **V**		
INCOMING LUG	350 MCM	2 Lugs per Phase	
INCOMING PROVISION	From Bottom of unit 2A/9A		
COPPER HORIZONTAL BUS	1200 Amps Copper/Tin Plated Insulated	60 kA (RMS symmetrical)	
COPPER GROUND BUS	1/4" x 2" (6.4 x 51 mm)		
ENCLOSURE	**NEMA** Type 1 - with Door Gasketing		
EXTERIOR PAINT	ANSI 61 - Light Grey	**LABELS**	English Only

COMMENTS
2" x 4" Inch [51 x 102 mm] Low Voltage Wire Duct

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CUSTOMER Colorado River MWD

LTR	REVISION	INT
1	ENG Program Approval 2012-02-21	PE

Allen-Bradley

CERTIFIED R. Yang **DATE** 2012-02-21

SHEET 7 **OF** 13

Rockwell Automation **DWG. NO.** 7012576-001-12D

AutoCAD®

UNIT DETAILS

DESCRIPTION
Main, Fused Load Break Switch.

ELEMENTARY DIAGRAM NUMBER
7012576-001-12E

UNIT LOCATIONS => CATALOG NUMBER
1A/2A, 8A/9A =>
1592MB-BDED-6PT-6T-84D1-804-5010D-5053-6001D-CM□D5

OPTIONS

6T	Potential Transformer Interwiring control for 3 phase voltage reference between incomers/main LBS and controller. Option includes appropriate wiring to terminal blocks and fusing. Note: This option does not include potential transformers.
6PT	Two (2) 500 VA potential transformers with primary and secondary fusing for controllers
84D1	Four (4) pole shorting terminal blocks
804	Twenty (20) extra unwired terminal blocks in the low voltage compartment
5010D	Cabinet space heater and thermostat supplied in each section of the unit. Power supplied from an external power source. The wattage depends on AC voltage, i.e. 85W @110V, 100W @ 120V, 330W @ 220V.
5053	Key Interlock for a two (2) Main, one (1) Tie Load Break Switch arrangement
6001D	Distribution Class Tranquell Heavy Duty arrestor. Heavy duty arrester suitable for all indoor applications as well as outdoor applications located in an area with yearly ground flash density of up to 4 per sq. km.
CM□D5	PQMIIT20CA

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CUSTOMER: Colorado River MWD

LTR	REVISION	INT
1	ENG Program Approval 2012-02-21	PE

Allen-Bradley

CERTIFIED: R. Yang
DATE: 2012-02-21
SHEET: 8 OF: 13
Rockwell Automation
DWG. NO. 7012576-001-12D

UNIT DETAILS

DESCRIPTION
2-High VFD Input Contactor Units

ELEMENTARY DIAGRAM NUMBER
7012576-001-12E

UNIT LOCATIONS => CATALOG NUMBER
3A, 3B, 7A, 7B =>
1512BD-ADE-1ESTP-1□N-1□FF-4□FFG-4□NR-6B-6T-17-84D7-803-3950S-4010-5010D-CM□D6

OPTIONS

1□N	□N, Push Button Located on the LV compartment door-Green
1□FF	□FF Push Button Located on the LV compartment door-Red
1ESTP	EMERGENCY ST□P (Push-Pull) Pushbutton Located on the LV compartment door-Red
4□NR	Red □N Pilot Light
4□FFG	Green □FF Pilot Light
6B	1000 VA control power transformer with primary and secondary fusing for controllers
6T	Potential Transformer Interwiring control for 3 phase voltage reference between incomers/main LBS and controller. □ption includes appropriate wiring to terminal blocks and fusing. Note: This option does not include potential transformers.
17	(1) - low voltage surge suppressor across each 120V coil in the control circuit, where possible
84D7	Multilin 515 blocking and test module
803	Fifteen (15) extra unwired terminal blocks in the low voltage compartment
3950S	Mechanically Latched Contactor with the standard trip option
4010	MV contactor control circuit with IntelliVAC module.
5010D	Cabinet space heater and thermostat supplied in each section of the unit. Power supplied from an external power source. The wattage depends on AC voltage, i.e. 85W @110V, 100W @ 120V, 330W @ 220V.
CM□D6	350EP5G5HESNNSNDN

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CUSTOMER: Colorado River MWD

LTR	REVISION	INT
1	ENG Program Approval 2012-02-21	PE

Allen-Bradley

CERTIFIED: R. Yang
DATE: 2012-02-21

SHEET 9 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

AutoCAD®

UNIT DETAILS

DESCRIPTION
Two-High, Full-Voltage Transformer Feeder Unit.

ELEMENTARY DIAGRAM NUMBER
7012576-001-12E

UNIT LOCATIONS => CATALOG NUMBER
4B, 6B =>
1512BT-TDE-1□N-1□FF-3-4□FFG-4□NR-6B-6T-84D7-803-3950S-4010-5010D-5051-CM□D6

OPTIONS

1□N	□N, Push Button Located on the LV compartment door-Green
1□FF	□FF Push Button Located on the LV compartment door-Red
3	HAND-□FF-AUT□ Selector Switch
4□NR	Red □N Pilot Light
4□FFG	Green □FF Pilot Light
6B	1000 VA control power transformer with primary and secondary fusing for controllers
6T	Potential Transformer Interwiring control for 3 phase voltage reference between incomers/main LBS and controller. □ption includes appropriate wiring to terminal blocks and fusing. Note: This option does not include potential transformers.
84D7	Multilin 515 blocking and test module
803	Fifteen (15) extra unwired terminal blocks in the low voltage compartment
3950S	Mechanically Latched Contactor with the standard trip option
4010	MV contactor control circuit with IntelliVAC module.
5010D	Cabinet space heater and thermostat supplied in each section of the unit. Power supplied from an external power source. The wattage depends on AC voltage, i.e. 85W @110V, 100W @ 120V, 330W @ 220V.
5051	Key Interlock to lock the external operating handle in the '□FF' position
CM□D6	350EP5G5HESNNSNDN

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CUSTOMER: Colorado River MWD

LTR	REVISION	INT
1	ENG Program Approval 2012-02-21	PE

Allen-Bradley

CERTIFIED: R. Yang
DATE: 2012-02-21
SHEET: 10 OF: 13
Rockwell Automation
DWG. NO. 7012576-001-12D

AutoCAD®

UNIT DETAILS

DESCRIPTION
Tie, Load Break Switch.

ELEMENTARY DIAGRAM NUMBER
7012576-001-12E

UNIT LOCATIONS => CATALOG NUMBER
5A =>
1594T-BDED-5053
OPTIONS
5053 Key Interlock for a two (2) Main, one (1) Tie Load Break Switch arrangement

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CUSTOMER Colorado River MWD

LTR	REVISION	INT
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CERTIFIED R. Yang | DATE 2012-02-21

SHEET 11 | OF 13

Rockwell Automation | DWG. NO. 7012576-001-12D

(J)

AutoCAD®

NAMEPLATE ENGRAVING LIST

MASTER NAMEPLATE (IF SPECIFIED)

.50" [13mm] HIGH LETTERING
14 LETTERS / LINE
3 LINES MAXIMUM
2.00" X 6.00" [51mm X 152mm]
WHITE W/ BLACK LETTERS

2A	TPSSWGR

UNIT NAMEPLATES

.187" [5mm] HIGH LETTERING
22 LETTERS MAX. LINES 1,3
20 LETTERS MAX. LINES 2
1.125" X 3.625 [29mm X 92mm]
WHITE W/ BLACK LETTERS

2A	INCOMING MAIN A
3B	VFD-TPSP2 FEEDER
4B	XFMR TPST1A FEEDER
6A	EMPTY UNIT
7A	VFD-TPSP3 FEEDER
9A	INCOMING MAIN B

3A	VFD-TPSP1 FEEDER
4A	EMPTY UNIT
5A	TIE BREAKER
6B	XFMR TPST1B FEEDER
7B	VFD TPSP4 FEEDER

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CUSTOMER: Colorado River MWD

LTR	REVISION	INT
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CERTIFIED: R. Yang
DATE: 2012-02-21

SHEET 12 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

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LOAD/CONTROLLER DATA

UNIT LOCATION		1A/2A 8A/9A	3A/3B 7A/7B	4B 6B	5A				
BULLETIN		1592MB	1512BD	1512BT	1594T				
LOAD RATING		–	1500 hp	500 kVA	–				
DRIVE SERVICE FACTOR		–	1.0	–	–				
CONTROLLER	LOAD CABLE EXIT DIRECTION	–	Top	Bottom	–				
	LOAD LUG SIZE & QTY. PER PHASE	–	#1/0 (1)	#2 (1)	–				
	OVERLOAD ELEMENTS	–	–	–	–				
	C.T. RATIO	600/5	300/5	100/5	–				
	POWER FUSE RATING	57X	19R	100E	–				
	MAXIMUM CONTINUOUS CURRENT ALLOWED BY FUSES (A)	1340	275	80	–				
	POWER CELL RATING (A)	600	260	180	600				
LOAD	SERVICE FACTOR	–	–	–	–				
	FULL LOAD CURRENT (A)	–	197	69	–				
	LOCKED ROTOR CURRENT (A)	–	–	–	–				
	ACCELERATION TIME OF LOAD (s)	–	–	–	–				
	MAXIMUM LOCKED ROTOR TIME (s) HOT / COLD	–	–	–	–				
	POWER FACTOR	–	–	–	–				
	DC FIELD CURRENT (A)	–	–	–	–				
	DC FIELD VOLTAGE (V)	–	–	–	–				
	INDUCED CURRENT AT % SPEED (A) 0% / 95%	–	–	–	–				
	FIELD DISCHARGE RESISTANCE (Ω)	–	–	–	–				

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CUSTOMER: Colorado River MWD

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1	ENG Program Approval 2012-02-21	PE

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CERTIFIED: R. Yang

DATE: 2012-02-21

SHEET 13 OF 13

Rockwell Automation

DWG. NO. 7012576-001-12D

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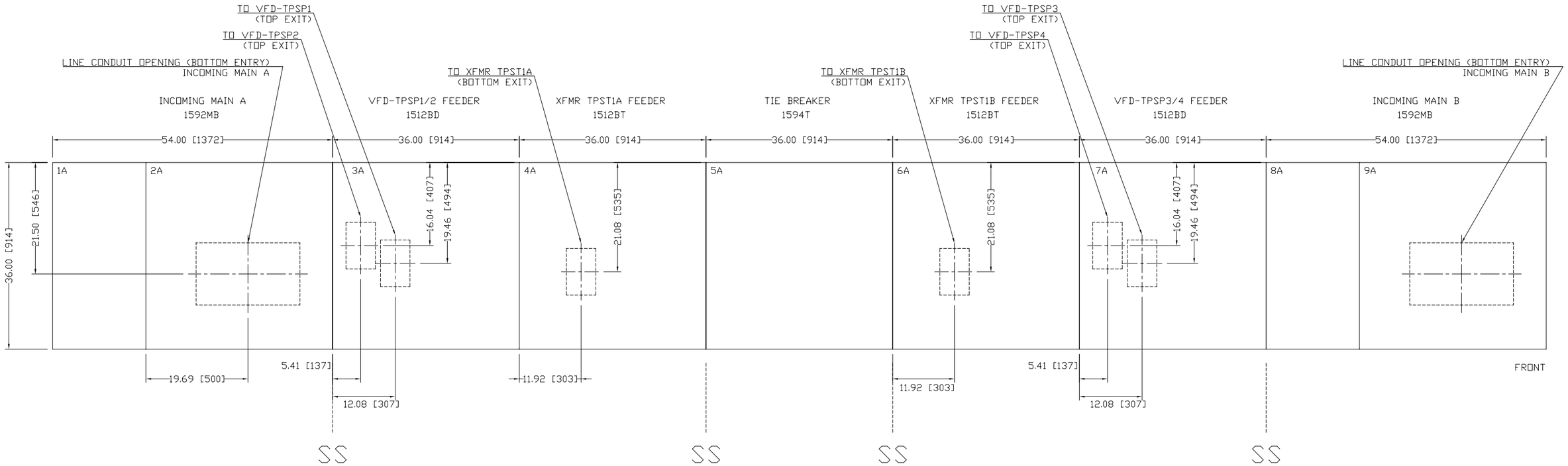

TOTAL WIDTH = 288 [7315.2]

DIMENSIONS = in [mm]

SS = SHIPPING SPLIT

ONLY MV CONDUIT OPENINGS ARE SHOWN ON THIS DRAWING

FOR LV CONDUIT OPENINGS, PLEASE REFER TO THE RESPECTIVE DIMENSIONAL DRAWINGS

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CERTIFIED	DATE	REV	REVISION	INT	DATE
R. Yang	2012-02-17	1	ENG PROGRAM APPROVAL	RY	2012-02-17
DRAWN	DATE				
R. Yang	2012-02-17				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION
PLAN LAYOUT DRAWING
TPSSWGR

BULLETIN			
SIZE			
Rockwell Automation	REV	DWG. NO.	SHEET 1
	1	7012576-001-12PL	OF 1

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E-IM-C

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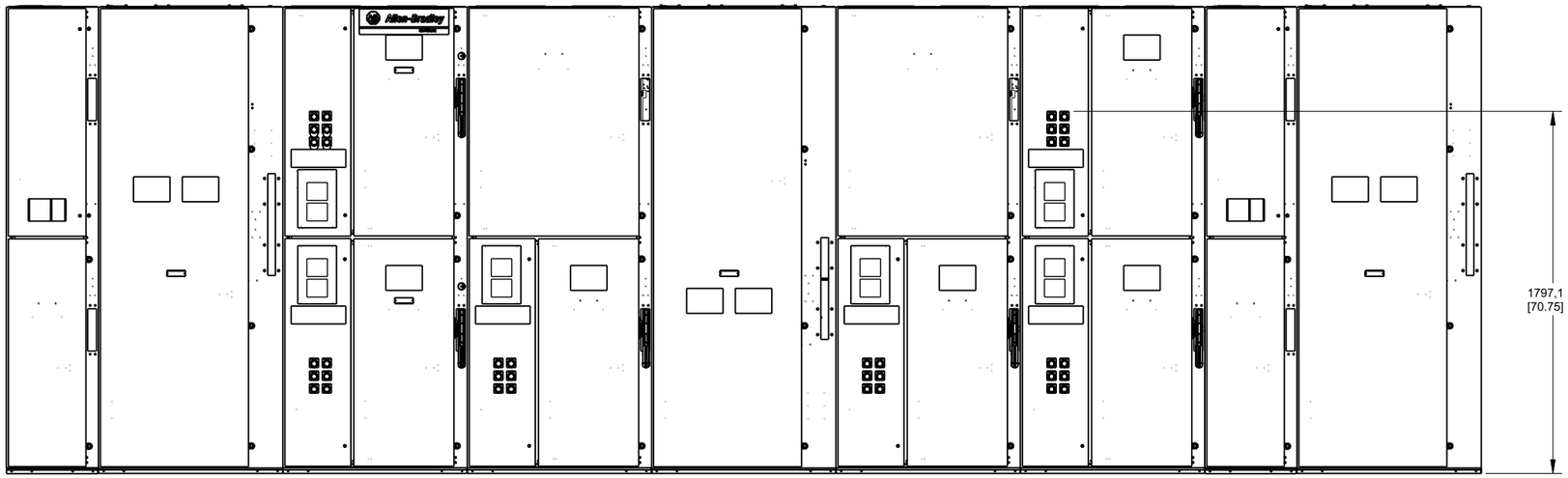
TPSSWGR

FRONT VIEW OF STARTERS SHOWN



1592MB
INCOMING MAIN A

1512BD
VFD-TPSP1/2
FEEDER

1512BT
XFMR TPST1A
FEEDER

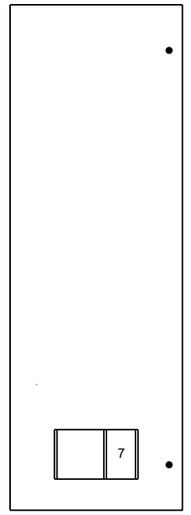
1592T
TIE BREAKER

1512BT
XFMR TPST1B
FEEDER

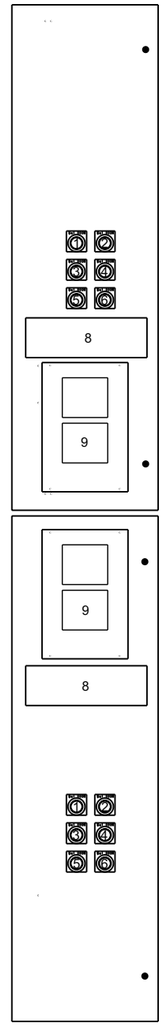
1512BD
VFD-TPSP3/4
FEEDER

1592MB
INCOMING MAIN B

(TYPICAL)
18" CABINET
DOOR
LAYOUT



(TYPICAL)
STARTER
DOOR
LAYOUT



1) ON - PL
2) OFF - PL
3) ON - PB
4) OFF - PB
5) H-O-A - SS
6) PLUG

7) MULTILIN PQM
8) 515 TESTBLOCK
9) MULILIN 350

R PARTS MUST CONFORM TO ROCKWELL AUTOMATION ENVIRONMENTAL SPECIFICATION 970-20-01

DIMENSIONS IN []:INCH

USER ID: SSHEPARD	DIMENSIONS IN MILLIMETRES	BULLETIN 1500	SIZE -	TYPE EEMAC/NEMA -
	TOLERANCES UNLESS OTHERWISE SPECIFIED	CUSTOMER LAYOUT		
	ANGLES ± 1°	-		
ECN NUMBER: RELEASED	1 DECIMAL (X.X) ±0,8	MEDIUM VOLTAGE		
	2 DECIMAL (X.XX) ±0,25	-		
		1500 STARTERS		
		-		
		-		
		-		
REV. NO. 1	Rockwell Automation	REF. -	-	
		A-B ORDER NO. -		

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Allen-Bradley

DR. Steven Shepard — DATE 23/02/2012

CHKD. — DATE

SHEET 1 OF 1

DWG. NO. 7012576-001-12SL

MVBDH06

Pro/ENGINEER®

CUSTOMER: WARD COUNTY WATER SUPPLY

CUSTOMER ORDER NUMBER:

DISTRIBUTOR: THE REYNOLDS COMPANY

DISTRIBUTOR ORDER NUMBER: P.O.# 1638098-00

PROJECT: TRANSMISSION PUMP STATION

PROJECT ORDER NUMBER:

ROCKWELL AUTOMATION ORDER NUMBER: 7012576

SERIES NUMBER	UNIT NUMBER	EQUIPMENT DESCRIPTION	PAGE DESCRIPTION	SHEET
			PROJECT TITLE AND DRAWING INDEX	1
			GENERAL NOTES AND DEVICE DESIGNATIONS	2
			ONE LINE DIAGRAM AND KEY INTERLOCKING	3
			POWER WIRING INTERCONNECTIONS	4
			CONTROL WIRING INTERCONNECTIONS AND TERMINAL BLOCK LAYOUTS	5-12
7012576-001-12	1A/2A		INCOMING MAIN A	13
7012576-002-12	3A	DRIVE RELATED STARTER	VFD-TPSP1 FEEDER	14
7012576-002-12	3B	DRIVE RELATED STARTER	VFD-TPSP2 FEEDER	15
7012577-003-12	4B		XFMR TPST1A FEEDER	16
7012577-008-12	5A		TIE BREAKER	17
7012577-007-12	6B		XFMR TPST1B FEEDER	18
7012576-006-12	7A	DRIVE RELATED STARTER	VFD-TPSP3 FEEDER	19
7012576-006-12	7B	DRIVE RELATED STARTER	VFD-TPSP4 FEEDER	20
7012577-005-12	8A/9A		INCOMING MAIN B	21
			SYMBOL TABLE	22

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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

		ORDER NO.
CUSTOMER	WARD COUNTY WATER SUPPLY	
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

TPSSWGR

DESCRIPTION: WARD COUNTY WATER SUPPLY DRAWING INDEX

BULLETIN | SIZE | REV 1 | DWG. NO. 7012576-001-12E | SHEET 1 OF 22

Rockwell Automation

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GENERAL NOTES

/1 REMOTE EQUIPMENT

/5 LOW VOLTAGE DOOR MOUNTED DEVICE

/6 FOR CUSTOMER USE.

/7 MECHANICAL INTERLOCK

/8 CURRENT LIMITING

/23 DANGER: MORE THAN ONE LIVE CIRCUIT.

/33 CAUTION:
USE OF SHORTING TERMINAL BLOCK WILL OVERRIDE METERING DEVICES AND/OR PROTECTION RELAYS.

/52 MULTILIN PQM TO BE PROGRAMMED BY THE CUSTOMER BEFORE START-UP.

/70 WIRED FROM THE TIE BREAKER

/102 LV CONTROL WIRING WITHIN THE UNITS SHALL BE #14 AWG UNLESS OTHERWISE NOTED.
LV CONTROL WIRING BETWEEN THE UNITS SHALL BE #14 AWG UNLESS OTHERWISE NOTED.

DEVICE DESIGNATIONS

AC - ALTERNATING CURRENT

AUX - INTELLIVAC MODULE VACUUM CONTACTOR AUXILIARY INPUT

BTM - BLOCKING AND TEST MODULE

CCO - INTELLIVAC MODULE CLOSING COIL OUTPUT

CPT - CONTROL POWER TRANSFORMER

CSH - CABINET SPACE HEATER

CSHT - CABINET SPACE HEATER THERMOSTAT

CT - CURRENT TRANSFORMER

DFTB - DRIVE FEEDER TERMINAL BLOCK

EC - INTELLIVAC MODULE EXTERNAL CAPACITOR INPUT

F - FUSE

FPS - FEEDER PROTECTION SYSTEM

GFCT - GROUND FAULT CURRENT TRANSFORMER

GRD - GROUND

IS - ISOLATING SWITCH

LA - LIGHTNING ARRESTOR

LV - LOW VOLTAGE

LBS - LOAD BREAK SWITCH

MOV - METAL OXIDE VARISTOR

M - MAIN CONTACTOR

M-IV - MAIN CONTACTOR INTELLIVAC MODULE

MTB - MAIN LBS TERMINAL BLOCK

MV - MEDIUM VOLTAGE

PE - EARTH POTENTIAL

PT - POTENTIAL TRANSFORMER

PQM - POWER QUALITY METER

SC - SURGE CAPACITOR

SG - SAFETY GROUND

STB - SHORTING TERMINAL BLOCK

SW - SWITCH

TCO - INTELLIVAC MODULE TRIP COIL OUTPUT

TS - TEST SUPPLY POINT

XTB - TRANSFORMER FEEDER TERMINAL BLOCK

COLOUR DESIGNATIONS

A	AMBER
BLK	BLACK
B	BLUE
BR	BROWN
C	CLEAR
G	GREEN
ORG	ORANGE
R	RED
W	WHITE
Y	YELLOW

ABBREVIATIONS

AC	ALTERNATING CURRENT
DC	DIRECT CURRENT
GND	GROUND
LV	LOW VOLTAGE
MV	MEDIUM VOLTAGE
PE	EARTH GROUND
SG	SAFETY GROUND
TE	SIGNAL GROUND

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CERTIFIED	R.YANG	DATE	2012-02-23	REV	1	REVISION	ENG PROGRAM APPROVAL
DRAWN	M.KEIL	DATE	2012-02-09				

INT	DATE
MK	2012-02-23

CUSTOMER	WARD COUNTY WATER SUPPLY
DISTRIBUTOR	THE REYNOLDS COMPANY
PROJECT	TRANSMISSION PUMP STATION

ORDER NO.: P.O.# 1638098-00

DESCRIPTION: GENERAL NOTES AND DEVICE DESIGNATIONS

BULLETIN:

SIZE:

Rockwell Automation

REV: 1

DWG. NO.: 7012576-001-12E

SHEET 2 OF 22

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E-DH-C

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KEY INTERLOCK SYSTEM SUPPLIED BY ROCKWELL AUTOMATION

DANGER

SYSTEM INTEGRITY DEPENDS ON HAVING THE NUMBER OF KEYS NOTED BELOW FOR EACH INTERCHANGE DESIGNATION. IF MORE KEYS ARE AVAILABLE THE INTERLOCKING INTEGRITY IS LOST. SAFETY OF PERSONNEL AND EQUIPMENT WILL BE AFFECTED.

THE CUSTOMER MUST ENSURE THAT HIS CONFIGURATION OF THIS EQUIPMENT INTO HIS SYSTEM DOES NOT RESULT IN DAMAGE TO THIS EQUIPMENT. THE SYSTEM SHOWN HERE IS DESIGNED TO ACHIEVE THE FUNCTION DESCRIBED BELOW.

DANGER

TIE SYSTEM
BOTH SIDES OF SWITCHING DEVICES ARE SUPPLIED FROM SEPARATE POWER SOURCES. DE-ENERGIZE TIE SWITCH BEFORE SERVICING. FAILURE TO DE-ENERGIZE POWER CAN RESULT IN SEVERE INJURY OR DEATH.

TWO (2) MAIN, ONE (1) TIE LOAD BREAK SWITCH ARRANGEMENT

ONLY TWO (2) OF THE THREE (3) SWITCHES CAN BE CLOSED AT ANY ONE TIME.

INTERLOCK SCHEME

THE INTERLOCK SCHEME IS DESIGNED TO PREVENT ACCESS TO MEDIUM VOLTAGE CELLS UNTIL ALL SOURCES FEEDING THAT CELL HAVE BEEN REMOVED.

TO OPERATE XFMR TPST1A FEEDER

1) IF TPST1B IS ON AS INDICATED BY THE PILOT LIGHT, PUSH THE OFF BUTTON TO OPEN THE CONTACTOR
2) OPEN THE TPST1B ISOLATION SWITCH AND LOCK IT OPEN TO REMOVE KEY K1
3) KEY K1 CAN BE USED TO UNLOCK THE TPST1A ISOLATION SWITCH
NOTE: ONLY ONE (1) OF THE TWO (2) SWITCHES CAN BE CLOSED AT ANY ONE TIME

TO OPERATE XFMR TPST1B FEEDER

1) IF TPST1A IS ON AS INDICATED BY THE PILOT LIGHT, PUSH THE OFF BUTTON TO OPEN THE CONTACTOR
2) OPEN THE TPST1A ISOLATION SWITCH AND LOCK IT OPEN TO REMOVE KEY K1
3) KEY K1 CAN BE USED TO UNLOCK THE TPST1B ISOLATION SWITCH
NOTE: ONLY ONE (1) OF THE TWO (2) SWITCHES CAN BE CLOSED AT ANY ONE TIME

KEY QUANTITIES

THE FOLLOWING KEY QUANTITIES ARE REQUIRED TO MAINTAIN KEY INTERLOCK SCHEME INTEGRITY

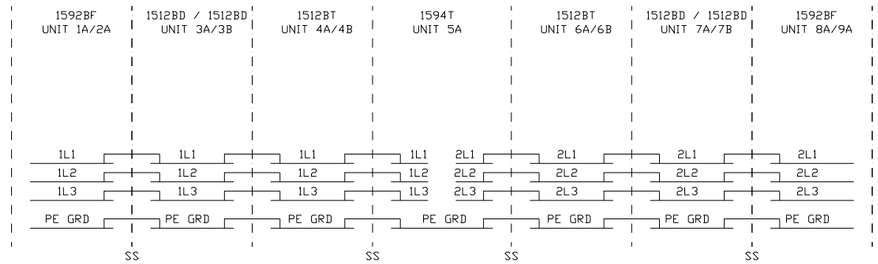
(K1) ONE (1) (K2) TWO (2)

LEGEND

L-O LOCKED OPEN

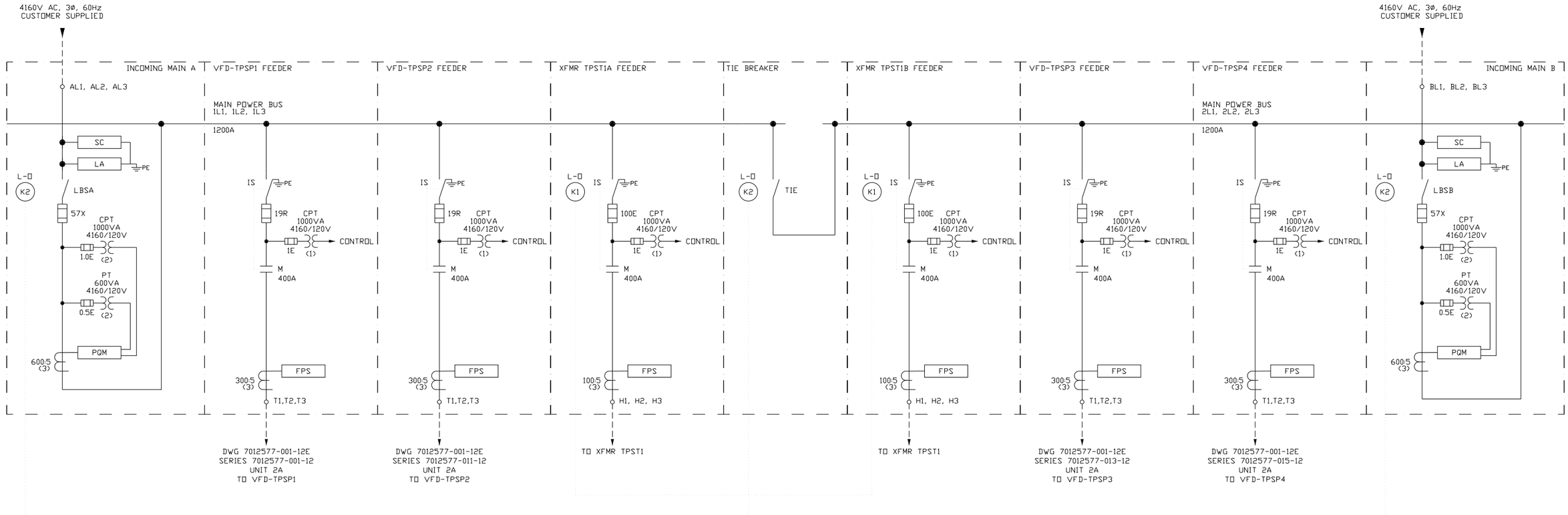
(K) KEY INTERLOCK ON ISOLATION SWITCH

BUS LINK CONNECTIONS



SS - SHIPPING SPLIT

CUSTOMER TO CONNECT UNITS AT SHIPPING SPLITS (SS) AS INDICATED USING BUS LINKS SUPPLIED BY ROCKWELL AUTOMATION. REFER TO PUBLICATION 1500-UM055B-EN-P AND DWG 80158-996.



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	DRAWN M.KEIL	DATE 2012-02-09					DISTRIBUTOR: THE REYNOLDS COMPANY	P.O.# 1638098-00			REV 1
							PROJECT: TRANSMISSION PUMP STATION				DWG. NO. 7012576-001-12E

Allen-Bradley — Rockwell Automation — SHEET 3 OF 22

E-DH-C — AutoCAD®

DWG 7012577-001-12E
SERIES 7012577-011-12
UNIT 2A
TO VFD-TPSP2

DWG 7012577-001-12E
SERIES 7012577-001-12
UNIT 2A
TO VFD-TPSP1

5kV MIN.

5kV MIN.

DWG 7012577-001-12E
SERIES 7012577-015-12
UNIT 2A
TO VFD-TPSP4

DWG 7012577-001-12E
SERIES 7012577-013-12
UNIT 2A
TO VFD-TPSP3

5kV MIN.

5kV MIN.

INCOMING MAIN A	VFD-TPSP1 FEEDER / VFD-TPSP2 FEEDER	XFMR TPST1A FEEDER	TIE BREAKER	XFMR TPST1B FEEDER	VFD-TPSP3 FEEDER / VFD-TPSP4 FEEDER	INCOMING MAIN B
1592MB SERIES	1512BD/1512BD SERIES	1512BT SERIES	1594T SERIES	1512BT SERIES	1512BD/1512BD SERIES	1592MB SERIES
7012576-001-12	7012576-002-12	7012576-003-12	7012576-008-12	7012576-007-12	7012576-006-12	7012576-005-12

1 A 2 A 3 A 3 A 4 A 5 A 6 A 7 A 7 A 8 A 9 A

LV MV LV MV MV MV MV LV MV LV MV

T1 T2 T3 T1 T2 T3

PE GRD

AL1 AL2 AL3

BL1 BL2 BL3

1 A 3 B 3 B 4 B 4 B 6 B 6 B 7 B 7 B 8 A

H1 H2 H3 H1 H2 H3

MV LV MV LV MV LV MV LV MV MV

5kV MIN. 5kV MIN. 5kV MIN. 5kV MIN. 5kV MIN.

CUSTOMER SUPPLIED GROUND

CUSTOMER SUPPLIED GROUND

4160V AC, 3ø, 60Hz
CUSTOMER SUPPLIED

TO XFMR TPST1

4160V AC, 3ø, 60Hz
CUSTOMER SUPPLIED

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CERTIFIED	R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN	M.KEIL	2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY
DISTRIBUTOR	THE REYNOLDS COMPANY
PROJECT	TRANSMISSION PUMP STATION

ORDER NO.: P.O.# 1638098-00

DESCRIPTION: POWER WIRING INTERCONNECTIONS AND KEY INTERLOCKING

BULLETIN

SIZE

Rockwell Automation

REV 1

DWG. NO. 7012576-001-12E

SHEET 4 OF 22

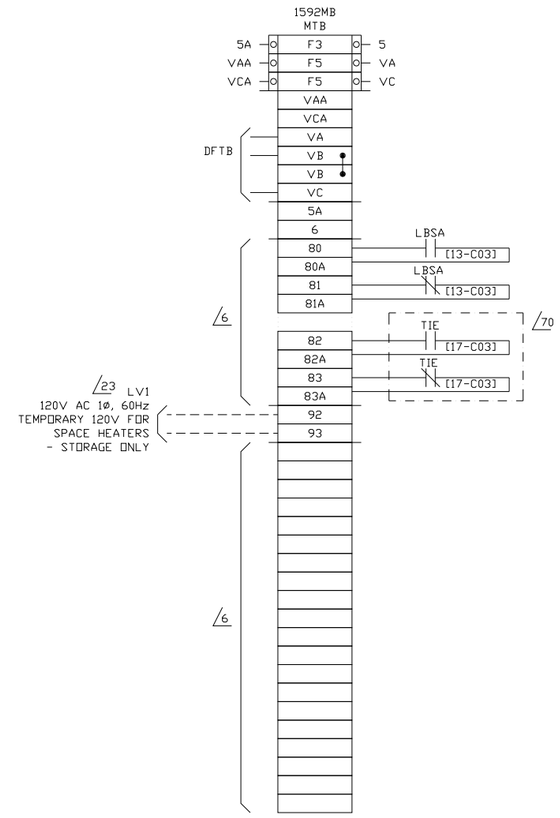
Allen-Bradley

E-DM-C

AutoCAD®

INCOMING MAIN A

SERIES 7012576-001-12



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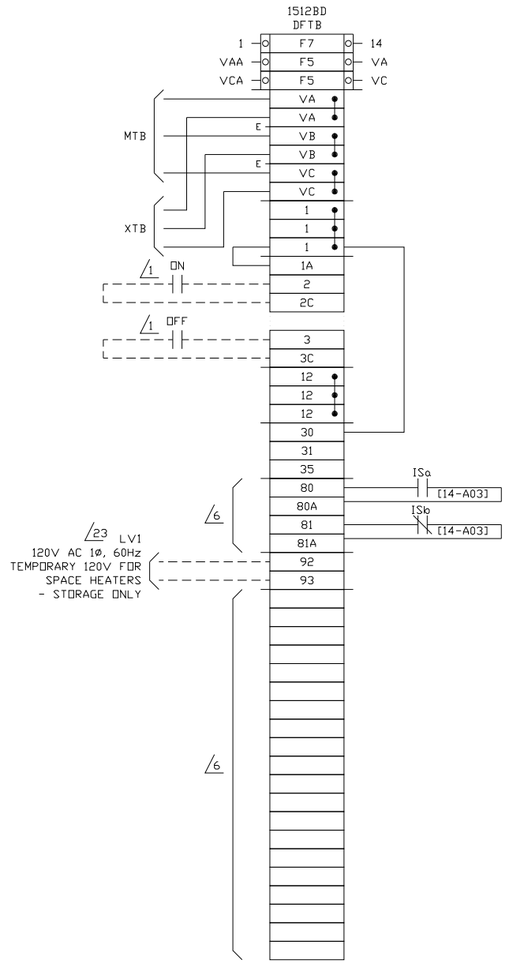
	DRAWN M.KEIL	DATE 2012-02-09					DISTRIBUTOR: THE REYNOLDS COMPANY	P.O.# 1638098-00		SIZE	
							PROJECT: TRANSMISSION PUMP STATION			Rockwell Automation REV 1	DWG. NO. 7012576-001-12E SHEET 5 OF 22

E-DH-C

AutoCAD®

VFD-TPSP1 FEEDER

SERIES 7012576-002-12



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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION
CONTROL WIRING INTERCONNECTIONS AND TERMINAL BLOCK LAYOUTS

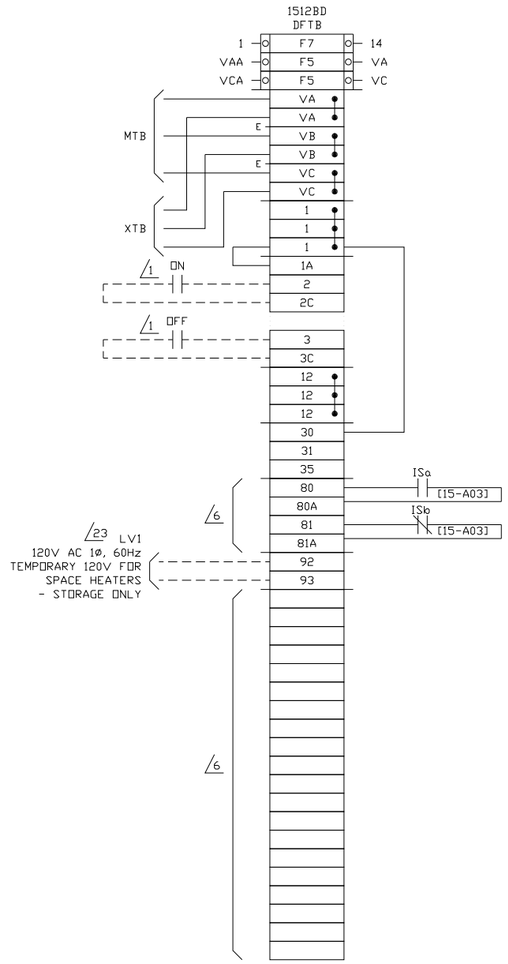
BULLETIN 1512BD		Allen-Bradley	
SIZE			
Rockwell Automation	REV 1	DWG. NO. 7012576-001-12E	SHEET 6 OF 22

E-DH-C

AutoCAD®

VFD-TPSP2 FEEDER

SERIES 7012576-002-12



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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION
CONTROL WIRING INTERCONNECTIONS AND TERMINAL BLOCK LAYOUTS

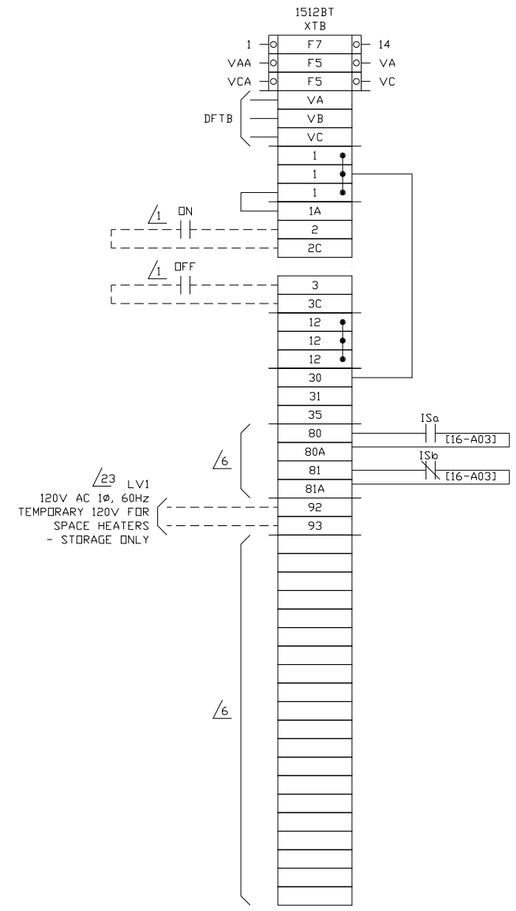
BULLETIN 1512BD		Allen-Bradley	
SIZE			
Rockwell Automation	REV 1	DWG. NO. 7012576-001-12E	SHEET 7 OF 22

E-DH-C

AutoCAD®

XFMR TPSPT1A FEEDER

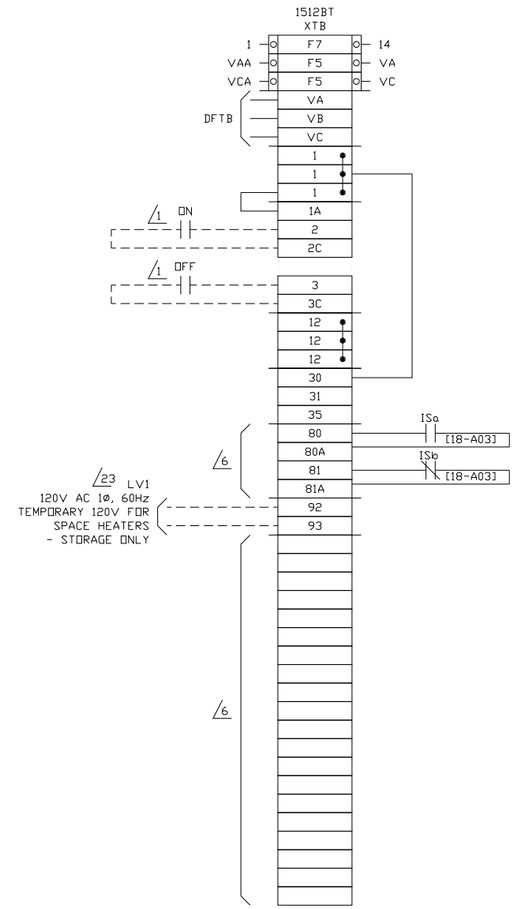
SERIES 7012576-003-12



| | | |

XFMR TPSPT1B FEEDER

SERIES 7012576-007-12



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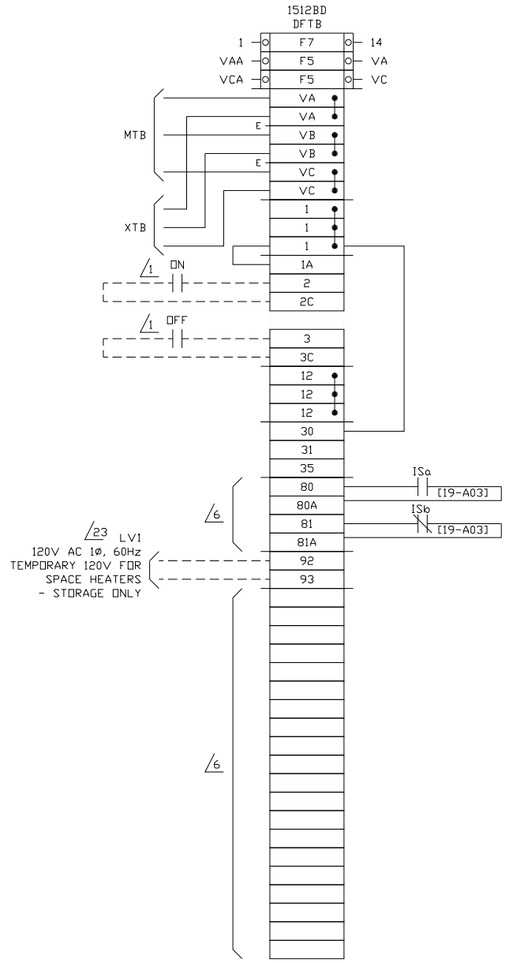
	DRAWN M.KEIL	DATE 2012-02-09					DISTRIBUTOR THE REYNOLDS COMPANY	P.O.# 1638098-00		SIZE	
							PROJECT TRANSMISSION PUMP STATION			Rockwell Automation REV 1	DWG. NO. 7012576-001-12E
											SHEET 9 OF 22

E-DH-C

AutoCAD®

VFD-TPSP3 FEEDER

SERIES 7012576-006-12



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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION
CONTROL WIRING INTERCONNECTIONS AND TERMINAL BLOCK LAYOUTS

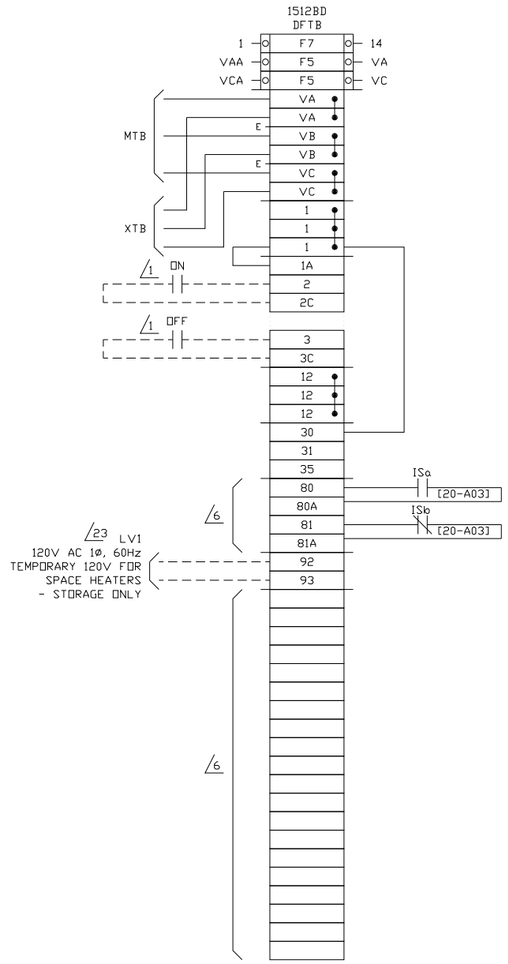
BULLETIN 1512BD		Allen-Bradley	
SIZE			
Rockwell Automation	REV 1	DWG. NO. 7012576-001-12E	SHEET 10 OF 22

E-DH-C

AutoCAD®

VFD-TPSP4 FEEDER

SERIES 7012576-006-12



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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION
CONTROL WIRING INTERCONNECTIONS AND TERMINAL BLOCK LAYOUTS

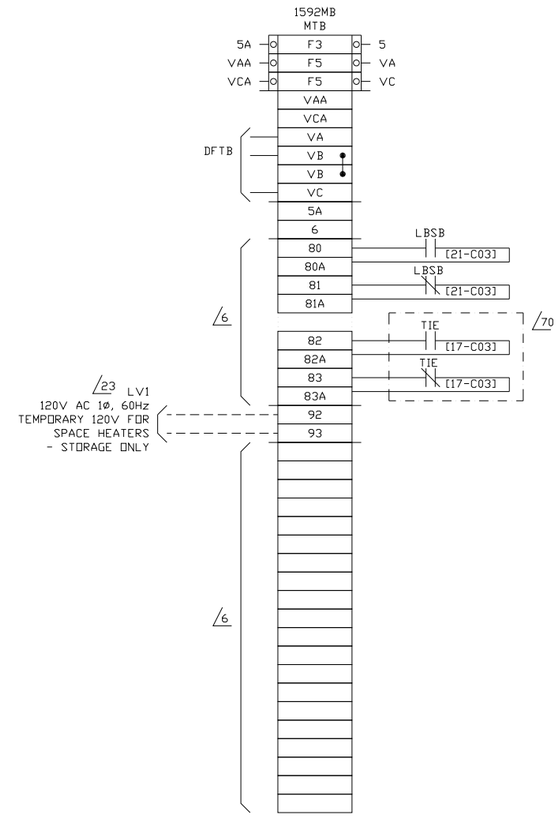
BULLETIN 1512BD		Allen-Bradley	
SIZE			
Rockwell Automation	REV 1	DWG. NO. 7012576-001-12E	SHEET 11 OF 22

E-DH-C

AutoCAD®

INCOMING MAIN B

SERIES 7012576-005-12



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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.	
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00	
PROJECT	TRANSMISSION PUMP STATION		

DESCRIPTION
CONTROL WIRING INTERCONNECTIONS AND TERMINAL BLOCK LAYOUTS

BULLETIN	1592MB		
SIZE			
Rockwell Automation	REV 1	DWG. NO. 7012576-001-12E	SHEET 12 OF 22

Allen-Bradley

E-DH-C

AutoCAD®

LBSA	
1	05-J08
2	05-J09

600A LBSA

4160V AC, 3ø, 60Hz CUSTOMER'S INCOMING LINE

AL1 AL2 AL3

4/0 AWG

#2 AWG

LA

SC

F1

CT1 CT2 CT3

/8

4160V AC, 3ø, 60Hz
1L1 1L2 1L3 GRD

/8 F2 1E F2 1E

4160 V

CPT 1000VA

H1 H2 X1 X3 X2 X4

120 V

5

2.0A F3

5A 6

/8 F6 0.5E F6 0.5E /8 F6 0.5E

4200 V H1 H2 X1 X2 120 V — PT1

4200 V H1 H2 X1 X2 120 V — PT2

VAA VB VCA

1.0A F5 VA

VB

1.0A F5 VC

3ø VOLTAGE REFERENCE

/5 /33 STB

42 44 46 47

42A 44A 46A 47A

VAA VB VCA

9	10	11	12	13	14	15	16	17	18	19	20	34	35	36	37	38	39	40	41	42	43	44	45	1	2	3	4
5A	1A	COM	5A	1A	COM	5A	1A	COM	5A	1A	COM													VI	V2	V3	VN
ø A			ø B			ø C			NEUTRAL			AUX.3			AUX.2			AUX.1			ALARM			VOLTAGE INPUTS		
CURRENT INPUTS												OUTPUT RELAYS															

/5 /52 PQM

MULTILIN PQM II
POWER QUALITY METER
P/N PQMII-T20-C-A

PROGRAMMABLE SWITCH INPUTS					4-20 mA ANALOG OUTPUTS					ANALOG INPUTS			RS485 SERIAL COM2			RS485 SERIAL COM1			CONTROL POWER			
SW1	SW2	SW3	SW4	+24V DC	COM	4+	3+	2+	1+	SHD	-	+	COM	-	+	COM	-	+	L / +	N / -	SAFETY GRD	FILTER GRD
32	31	30	29	33	24	25	26	27	28	21	22	23	49	50	51	46	47	48	8	7	6	5

COM3 RS232 FRONT — RS232

CUSTOMER SUPPLIED 120V AC

92 93

RATED AT 400W/240V

CSHT 92A CSH

/ SEE SHT.2

SEE SHEET 05 FOR TERMINAL BLOCK LAYOUT AND CUSTOMER INTERCONNECTIONS

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R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.	
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00	
PROJECT	TRANSMISSION PUMP STATION		

DESCRIPTION: INCOMING MAIN A

BULLETIN 1592MB — SIZE — REV 1 — DWG. NO. 7012576-001-12E — SHEET 13 OF 22

Allen-Bradley — Rockwell Automation

E-DH-C — AutoCAD®

4160V AC, 3ø, 60Hz

1L1 1L2 1L3 GRD

IS

F1 F1 F1

/8

IS	
+|+	06-J15
+|+	14-C12
+|+	06-J16
+|+	14-A16

MANUAL TRIP

M

50:5 GFCT

300:5 CT1 CT2 CT3

T1 T2 T3

TO VFD-TPSP1 SEE DRAWING 7012577-001-12E

48 49

FROM INCOMING MAIN A

VA 1.0A F5 VAA

VB VB

VC 1.0A F5 VCA

BTM /5 /33

1 2 3 4 5 6 21 22 23 24 25 26 27 28

42 44 46 47

15 16 17 18 19 20 7 8 9 10 11 12 13 14

48A 49A 42A 44A 46A 47A

F2 1E F2 1E

4160 V

CPT 1000 VA

H1 H2 X1 X3 X2 X4

120 V

5

ISa [14-A03]

OFF

NORMAL TEST

(1) (2)

8 (6) (5) 7 6

TEST SUPPLY POINT

ISb 9 [14-A03] (7) (8) 10 TS 11 12

120V 60Hz

(3) (4)

F3 8.0A

SW1 SW2

/2 M-IV

1 - EC 2 +

TCD 4 3

CCD 6 5

AUX 11 12

L1 G L2/N

M MOV TC MOV CC M

19 D B 21

17 C A 20

15 I M K 13 [14-F18]

M	
+|+	14-B34
+|+	14-D20
+|+	14-B35

2.0A F7 14

1 1A

FPS /5 A4 B4 V B5 2_CLOSE [14-J24]

2A HAND OFF AUTO /5 DN 2 /2 M-IV 9 + - 10 CLOSE 12

2C /1 DN

1

/5 OFF 3 /2 M-IV 7 + - 8 OPEN

3C /1 OFF

FPS /5 B6 A6 A5 3_AUX [14-J24]

1 30 E M F 31 [14-F18]

M J 35 [14-F18]

/5 R DN 12

/5 G OFF

FPS B1 POWER SUPPLY A1 [14-J24]

/ SEE SHT.2

14-B24 14-B31 14-D37

E9 D9 E10 D10 E11 D11 — VA VA VB VB VC VC — VOLTAGE INPUTS

E8 D8 E5 D5 E6 D6 E7 D7 — I_G I_C I_A I_C I_B I_C — CURRENT INPUTS

A2 B3 A3 B4 A4 B5 A5 B6 A6 B7 A7 B8 A8 B9 A9 B10 A10 B11 A11 B12 A12 — 1 TRIP, 2 CLOSE, 3 AUXILIARY, 4 AUXILIARY, 5 AUXILIARY, 6 AUXILIARY, 7 CRITICAL FAILURE RELAY — OUTPUT RELAYS

B1 A1 B2 — + - — POWER SUPPLY, CHASSIS GRD

/5 FPS

MULTILIN SR350
FEEDER PROTECTION SYSYTEM

DIGITAL INPUTS

C1 52a (CI #1) C2 52b (CI #2) C3 INPUT 3 C4 INPUT 4 C5 INPUT 5 C6 INPUT 6 C7 INPUT 7 C8 INPUT 8 C11 COMMON C12 CHASSIS GRD

COMMUNICATIONS

IRIG-B		RS485		
-	+	COM	-	+
F2	F1	F5	F4	F3

FRONT PANEL: USB TYPE B

REAR PANEL: ETHERNET RJ45 mTRJ

MULTILIN NOTES

OUTPUT RELAY CONTACTS SHOWN WITHOUT CONTROL POWER APPLIED

MULTILIN SR350 RELAY TO BE PROGRAMMED BY THE CONTRACTOR BEFORE START-UP.

92 CUSTOMER SUPPLIED 120V AC 93

RATED AT 400W/240V

CSHT 92A CSH

SEE SHEET 06 FOR TERMINAL BLOCK LAYOUT AND CUSTOMER INTERCONNECTIONS

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R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION: VFD-TPSP1 FEEDER

BULLETIN 1512BD SIZE

Rockwell Automation

Allen-Bradley

REV 1 DWG. NO. 7012576-001-12E SHEET 14 OF 22

E-DH-C

AutoCAD®

4160V AC, 3ø, 60Hz

1L1 1L2 1L3 GRD

IS

F1 F1 F1

/8

IS	
⊣⊢	07-J15
⊣⊢	15-C12
⊣/⊢	07-J16
⊣/⊢	15-A16

/7

MANUAL TRIP

M

50:5 GFCT

300:5 CT1 CT2 CT3

T1 T2 T3

TO VFD-TPSP2 SEE DRAWING 7012577-001-12E

48 49

FROM INCOMING MAIN A

VA VB VC — 1.0A F5 — VAA VB VCA

BTM /5 /33

1 2 3 4 5 6 21 22 23 24 25 26 27 28

42 44 46 47

15 16 17 18 19 20 7 8 9 10 11 12 13 14

48A 49A 42A 44A 46A 47A

F2 1E F2 1E

4160 V

CPT 1000 VA

H1 H2

X1 X3 X2 X4

120 V

5

ISa [15-A03]

OFF

NORMAL TEST

(1) (2)

8 (6) (5) 7 6

TEST SUPPLY POINT

ISb 9 [15-A03] (7) (8) 10 TS 11 (3) (4) 12

120V 60Hz

F3 8.0A

SW1 SW2

/2 M-IV

1 - EC 2 +

TCO 4 3

CCO 6 5

AUX 11 12

L1 G L2/N

15 I M K 13 [15-F18]

19 D TC B 21

17 C CC A 20

M MOV M

M	
⊣⊢	15-B34
⊣/⊢	15-D20
⊣/⊢	15-B35

2.0A F7 14

1 1A

FPS /5 A4 B4 V B5 2_CLOSE [15-J24]

HAND OFF AUTO

2A

/5 ON 2 2C /1 ON

/2 M-IV 9 + - 10 CLOSE 12

1

/5 OFF 3 3C /1 OFF

/2 M-IV 7 + - 8 OPEN

FPS /5 B6 A6 A5 3_AUX [15-J24]

1 30 E M F 31 [15-F18]

M J 35 [15-F18]

/5 R ON 12

/5 G OFF

FPS B1 POWER SUPPLY A1 [15-J24]

/ SEE SHT.2

15-B24 15-B31 15-D37

| | | |

4160V AC, 3ø, 60Hz

1L1 1L2 1L3 GRD

IS

F1 F1 F1

/8

IS	
+|+	08-J15
+|+	16-C12
+|+	08-J16
+|+	16-A16

/7

MANUAL TRIP

50:5 GFCT

100:5 CT1 CT2 CT3

H1 H2 H3

/1 XFMR TPST1

M

48 49

F2 1E F2 1E

4160 V

CPT 1000 VA H1 H2

X1 X3 X2 X4

120 V

5 ISa [16-A03]

FROM DFTB

VA 1.0A F5 VAA

VB VB

VC 1.0A F5 VCA

BTM /5 /33

1	2	3	4	5	6	21	22	23	24	25	26	27	28
15	16	17	18	19	20	7	8	9	10	11	12	13	14

42 44 46 47

48A 49A 42A 44A 46A 47A

OFF

NORMAL TEST

8 (6) (5) 7 6 (1) (2)

TEST SUPPLY POINT

ISb 9 [16-A03] 10 TS 11 12

120V 60Hz (8) (3) (4)

F3 8.0A

SW1 SW2

/2 M-IV

1 - EC 2 +

TCD 4 3

CCD 6 5

AUX 11 12

L1 G L2/N

M MOV TC MOV CC M

19 D B 21

17 C A 20

15 I M K 13 [16-F18]

2.0A F7 14

M	
+|+	16-B34
+|+	16-B35
+|+	16-D20

1A 1 FPS /5 A4 B4 V B5 2_CLOSE [16-J24]

HAND OFF AUTO 2A

/5 ON 2 /2 M-IV 9 + - 10 CLOSE 12

2C /1 ON

/5 OFF 3 /2 M-IV 7 + - 8 OPEN

3C /1 OFF

FPS /5 B6 A6 A5 3_AUX [16-J24]

30 E M F 31 [16-F18]

M J 35 [16-F18]

/5 R ON 12

/5 G OFF

FPS B1 POWER SUPPLY A1 [16-J24]

/ SEE SHT.2

16-B24 16-B31 16-D37

E9	D9	E10	D10	E11	D11
VA	VA	VB	VB	VC	VC

VOLTAGE INPUTS

E8	D8	E5	D5	E6	D6	E7	D7
I_G	I_G	I_A	I_A	I_B	I_B	I_C	I_C

CURRENT INPUTS

A2	B3	A3	B4	A4	B5	A5	B6	A6	B7	A7	B8	A8	B9	A9	B10	A10	B11	A11	B12	A12
V			V																	
1 TRIP			2 CLOSE			3 AUXILIARY			4 AUXILIARY			5 AUXILIARY			6 AUXILIARY			7 CRITICAL FAILURE RELAY		

OUTPUT RELAYS

B1	A1	B2
+	-	
POWER SUPPLY		CHASSIS GRD

/5 FPS MULTILIN SR350 FEEDER PROTECTION SYSYTEM

DIGITAL INPUTS

C1	C2	C3	C4	C5	C6	C7	C8	C11	C12
52a (CI #1)	52b (CI #2)	INPUT 3	INPUT 4	INPUT 5	INPUT 6	INPUT 7	INPUT 8	COMMON	CHASSIS GRD

COMMUNICATIONS

IRIG-B		RS485		
-	+	COM	-	+
F2	F1	F5	F4	F3

FRONT PANEL: USB TYPE B

REAR PANEL: ETHERNET RJ45 mTRJ

MULTILIN NOTES

OUTPUT RELAY CONTACTS SHOWN WITHOUT CONTROL POWER APPLIED

MULTILIN SR350 RELAY TO BE PROGRAMMED BY THE CONTRACTOR BEFORE START-UP.

92 CUSTOMER SUPPLIED 120V AC 93

RATED AT 400W/240V

CSHT 92A CSH

SEE SHEET 08 FOR TERMINAL BLOCK LAYOUT AND CUSTOMER INTERCONNECTIONS

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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION: XFMR TPST1A FEEDER

BULLETIN 1512BT SIZE

Rockwell Automation

Allen-Bradley

REV 1 DWG. NO. 7012576-001-12E SHEET 16 OF 22

E-DH-C AutoCAD®

4160V AC, 3ø, 60Hz
1L1 1L2 1L3 GRD

TIE

4160V AC, 3ø, 60Hz
2L1 2L2 2L3 GRD

TIE	
⊣⊢	05-J11
⊣⊢	12-J11
⊣⊢	05-J12
⊣⊢	12-J12

SEE SHT.2

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DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION: TIE BREAKER

BULLETIN 1594T
SIZE
Rockwell Automation
REV 1
DWG. NO. 7012576-001-12E
SHEET 17
OF 22

Allen-Bradley

E-DH-C

AutoCAD®

4160V AC, 3ø, 60Hz

2L1 2L2 2L3 GRD

IS

F1 F1 F1

/8

IS	
+|+	09-J15
+|+	18-C12
+|+	09-J16
+|+	18-A16

/7

MANUAL TRIP

M

50:5 GFCT

100:5 CT1 CT2 CT3

H1 H2 H3

/1

XFMR TPST1

48 49

FROM DFTB

VA 1.0A F5 VAA

VB VB

VC 1.0A F5 VCA

BTM /5 /33

1	2	3	4	5	6	21	22	23	24	25	26	27	28
15	16	17	18	19	20	7	8	9	10	11	12	13	14

42 44 46 47

48A 49A 42A 44A 46A 47A

F2 1E F2 1E

4160 V

CPT 1000 VA

H1 H2

X1 X3 X2 X4

120 V

5

ISa [18-A03]

OFF

NORMAL TEST

(1) (2)

8 (6) (5) 7 6

TEST SUPPLY POINT

ISb 9 [18-A03] (7) 10 (8) TS 11 12

120V 60Hz

(3) (4)

F3 8.0A

SW1 SW2

/2 M-IV

1 - EC 2 +

TCD 4 3

CCD 6 5

AUX 11 12

L1 G L2/N

M MOV TC MOV CC M

19 D 17 C B 21 A 20

15 I M K 13 [18-F18]

2.0A F7 14

M	
+|+	18-B34
+|+	18-B35
+|+	18-D20

1A

FPS /5 A4 B4 V B5 2_CLOSE [18-J24]

2A HAND OFF AUTO /5 ON 2 2C /1 ON

/2 M-IV 9 + - 10 CLOSE 12

/5 OFF 3 3C /1 OFF

/2 M-IV 7 + - 8 OPEN

FPS /5 B6 A6 A5 3_AUX [18-J24]

30 E M F 31 [18-F18]

M J 35 [18-F18]

/5 R ON 12

/5 G OFF

FPS B1 POWER SUPPLY A1 [18-J24]

/ SEE SHT.2

18-B24 18-B31 18-D37

E9	D9	E10	D10	E11	D11	E8	D8	E5	D5	E6	D6	E7	D7	A2	B3	A3	B4	A4	B5	A5	B6	A6	B7	A7	B8	A8	B9	A9	B10	A10	B11	A11	B12	A12	B1	A1	B2
VA	VA	VB	VB	VC	VC	I_G	I_G	I_A	I_A	I_B	I_B	I_C	I_C	V			V																		+	-	
VOLTAGE INPUTS						CURRENT INPUTS								1 TRIP			2 CLOSE			3 AUXILIARY			4 AUXILIARY			5 AUXILIARY			6 AUXILIARY			7 CRITICAL FAILURE RELAY			POWER SUPPLY		CHASSIS GRD
														OUTPUT RELAYS																							

/5 FPS MULTILIN SR350 FEEDER PROTECTION SYSYTEM

DIGITAL INPUTS											
52a (CI #1)	52a (CI #2)	INPUT 3	INPUT 4	INPUT 5	INPUT 6	INPUT 7	INPUT 8	COMMON	CHASSIS GRD		
C1	C2	C3	C4	C5	C6	C7	C8	C11	C12		

COMMUNICATIONS					
IRIG-B		RS485			
-	+	COM	-	+	
F2	F1	F5	F4	F3	

FRONT PANEL: USB TYPE B

REAR PANEL: ETHERNET RJ45 mTRJ

MULTILIN NOTES

OUTPUT RELAY CONTACTS SHOWN WITHOUT CONTROL POWER APPLIED

MULTILIN SR350 RELAY TO BE PROGRAMMED BY THE CONTRACTOR BEFORE START-UP.

92 CUSTOMER SUPPLIED 120V AC 93

RATED AT 400W/240V

CSHT 92A CSH

SEE SHEET 09 FOR TERMINAL BLOCK LAYOUT AND CUSTOMER INTERCONNECTIONS

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CERTIFIED	DATE	REV	REVISION	INT	DATE
R.YANG	2012-02-23	1	ENG PROGRAM APPROVAL	MK	2012-02-23
DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY
DISTRIBUTOR	THE REYNOLDS COMPANY
PROJECT	TRANSMISSION PUMP STATION

ORDER NO. P.O.# 1638098-00

DESCRIPTION XFMR TPST1B FEEDER

BULLETIN 1512BT SIZE

Rockwell Automation

Allen-Bradley

REV 1 DWG. NO. 7012576-001-12E SHEET 18 OF 22

E-DH-C

AutoCAD®

4160V AC, 3ø, 60Hz

2L1 2L2 2L3 GRD

IS

F1 F1 F1

MANUAL TRIP

50:5 GFCT

300:5 CT1 CT2 CT3

T1 T2 T3

TO VFD-TPSP3 SEE DRAWING 7012577-001-12E

IS	
⊣⊢	10-J15
⊣⊢	19-C12
⊣/⊢	10-J16
⊣/⊢	19-A16

F2 1E F2 1E

4160 V

CPT 1000 VA

H1 H2 X1 X3 X2 X4

120 V

ISa [19-A03]

FROM INCOMING MAIN B

VA VB VC 1.0A F5 F5

VAA VB VCA

BTM

1 2 3 4 5 6 21 22 23 24 25 26 27 28

15 16 17 18 19 20 7 8 9 10 11 12 13 14

42 44 46 47

48 49

48A 49A 42A 44A 46A 47A

OFF NORMAL TEST

TEST SUPPLY POINT

ISb [19-A03] TS 120V 60Hz

F3 8.0A

SW1 SW2

M-IV

EC AUX TCD CCD L1 G L2/N

M MOV TC MOV CC

F7 2.0A

FPS A4 B4 V B5 2_CLOSE [19-J24]

HAND OFF AUTO

ON 2C OFF 3C

M-IV CLOSE OPEN

FPS A6 B6 A5 3_AUX [19-J24]

30 E M F [19-F18] M J [19-F18]

ON OFF

FPS B1 POWER SUPPLY A1 [19-J24]

M	
⊣⊢	19-B34
⊣/⊢	19-D20
⊣/⊢	19-B35

19-B24 19-B31 19-D37

VOLTAGE INPUTS: E9 D9 E10 D10 E11 D11 — VA VA VB VB VC VC

CURRENT INPUTS: E8 D8 E5 D5 E6 D6 E7 D7 — I_G I_C I_A I_A I_B I_B I_C I_C

OUTPUT RELAYS: A2 B3 A3 B4 A4 B5 A5 B6 A6 B7 A7 B8 A8 B9 A9 B10 A10 B11 A11 B12 A12

1 TRIP — 2 CLOSE — 3 AUXILIARY — 4 AUXILIARY — 5 AUXILIARY — 6 AUXILIARY — 7 CRITICAL FAILURE RELAY

B1 + A1 − B2 — POWER SUPPLY — CHASSIS GRD

FPS

MULTILIN SR350
FEEDER PROTECTION SYSYTEM

DIGITAL INPUTS

C1	C2	C3	C4	C5	C6	C7	C8	C11	C12
52a (CI #1)	52b (CI #2)	INPUT 3	INPUT 4	INPUT 5	INPUT 6	INPUT 7	INPUT 8	COMMON	CHASSIS GRD

COMMUNICATIONS

IRIG-B		RS485		
−	+	COM	−	+
F2	F1	F5	F4	F3

FRONT PANEL: USB TYPE B

REAR PANEL: ETHERNET RJ45 mTRJ

MULTILIN NOTES

OUTPUT RELAY CONTACTS SHOWN WITHOUT CONTROL POWER APPLIED

MULTILIN SR350 RELAY TO BE PROGRAMMED BY THE CONTRACTOR BEFORE START-UP.

92 CUSTOMER SUPPLIED 120V AC 93

RATED AT 400W/240V

CSHT 92A CSH

SEE SHT.2

SEE SHEET 10 FOR TERMINAL BLOCK LAYOUT AND CUSTOMER INTERCONNECTIONS

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DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION: VFD-TPSP3 FEEDER

BULLETIN 1512BD SIZE

Rockwell Automation

Allen-Bradley

REV 1 DWG. NO. 7012576-001-12E SHEET 19 OF 22

E-DH-C

AutoCAD®

4160V AC, 3Ø, 60Hz

2L1 2L2 2L3 GRD

IS

F1 F1 F1

/8

IS	
⊣⊢	11-J15
⊣⊢	20-C12
⊣/⊢	11-J16
⊣/⊢	20-A16

/7

MANUAL TRIP

M

50:5 GFCT

300:5 CT1 CT2 CT3

T1 T2 T3

TO VFD-TPSP4 SEE DRAWING 7012577-001-12E

FROM INCOMING MAIN A

VA VB VC — 1.0A F5 F5 — VAA VB VCA

48 49

F2 1E F2 1E

4160 V

CPT 1000 VA

H1 H2 X1 X3 X2 X4

120 V

5

ISa [20-A03]

BTM /5 /33

1 2 3 4 5 6 21 22 23 24 25 26 27 28 — 42 44 46 47

15 16 17 18 19 20 7 8 9 10 11 12 13 14

48A 49A 42A 44A 46A 47A

OFF

NORMAL TEST

8 (6) (5) 7 6 (1) (2)

TEST SUPPLY POINT

ISb 9 [20-A03] (8) 10 TS 120V 60Hz 11 (3) (4) 12

F3 8.0A

SW1 SW2 1 2 3 4 5 6 7 8 ON

/2 M-IV

1 - EC 2 + TCD 4 3 CCD 6 5 AUX 11 12 L1 G L2/N

M MOV TC MOV CC

19 D 17 C B 21 A 20

15 I M K 13 [20-F31]

M	
⊣⊢	20-B34
⊣/⊢	20-D20
⊣/⊢	20-B35

2.0A F7 14

FPS /5

1A 1 A4 B4 V B5 2_CLOSE [20-J24]

HAND OFF AUTO 2A /5 ON 2 /2 M-IV 9 + - 10 CLOSE 12

2C /1 ON

1 /5 OFF 3 /2 M-IV 7 + - 8 OPEN

3C /1 OFF

FPS /5 B6 A6 A5 3_AUX [20-J24]

1 30 E M F 31 [20-F18] /5 R ON 12

M J 35 [20-F18] /5 G OFF

FPS B1 POWER SUPPLY A1 [20-J24]

/ SEE SHT.2

20-B24 20-B31 20-D37

E9 D9 E10 D10 E11 D11 — VA VA VB VB VC VC — VOLTAGE INPUTS

E8 D8 E5 D5 E6 D6 E7 D7 — I_G I_C I_A I_A I_B I_B I_C I_C — CURRENT INPUTS

A2 B3 A3 B4 A4 B5 A5 B6 A6 B7 A7 B8 A8 B9 A9 B10 A10 B11 A11 B12 A12 — 1 TRIP, 2 CLOSE, 3 AUXILIARY, 4 AUXILIARY, 5 AUXILIARY, 6 AUXILIARY, 7 CRITICAL FAILURE RELAY — OUTPUT RELAYS

B1 A1 B2 — + - POWER SUPPLY, CHASSIS GRD

/5 FPS MULTILIN SR350 FEEDER PROTECTION SYSYTEM

DIGITAL INPUTS

C1 52a (CI #1) C2 52b (CI #2) C3 INPUT 3 C4 INPUT 4 C5 INPUT 5 C6 INPUT 6 C7 INPUT 7 C8 INPUT 8 C11 COMMON C12 CHASSIS GRD

COMMUNICATIONS

IRIG-B		RS485		
-	+	COM	-	+
F2	F1	F5	F4	F3

FRONT PANEL: USB TYPE B

REAR PANEL: ETHERNET RJ45 mTRJ

MULTILIN NOTES

OUTPUT RELAY CONTACTS SHOWN WITHOUT CONTROL POWER APPLIED

MULTILIN SR350 RELAY TO BE PROGRAMMED BY THE CONTRACTOR BEFORE START-UP.

92 CUSTOMER SUPPLIED 120V AC 93

RATED AT 400W/240V

CSHT 92A CSH

SEE SHEET 11 FOR TERMINAL BLOCK LAYOUT AND CUSTOMER INTERCONNECTIONS

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DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION: VFD-TPSP4 FEEDER

BULLETIN 1512BD SIZE

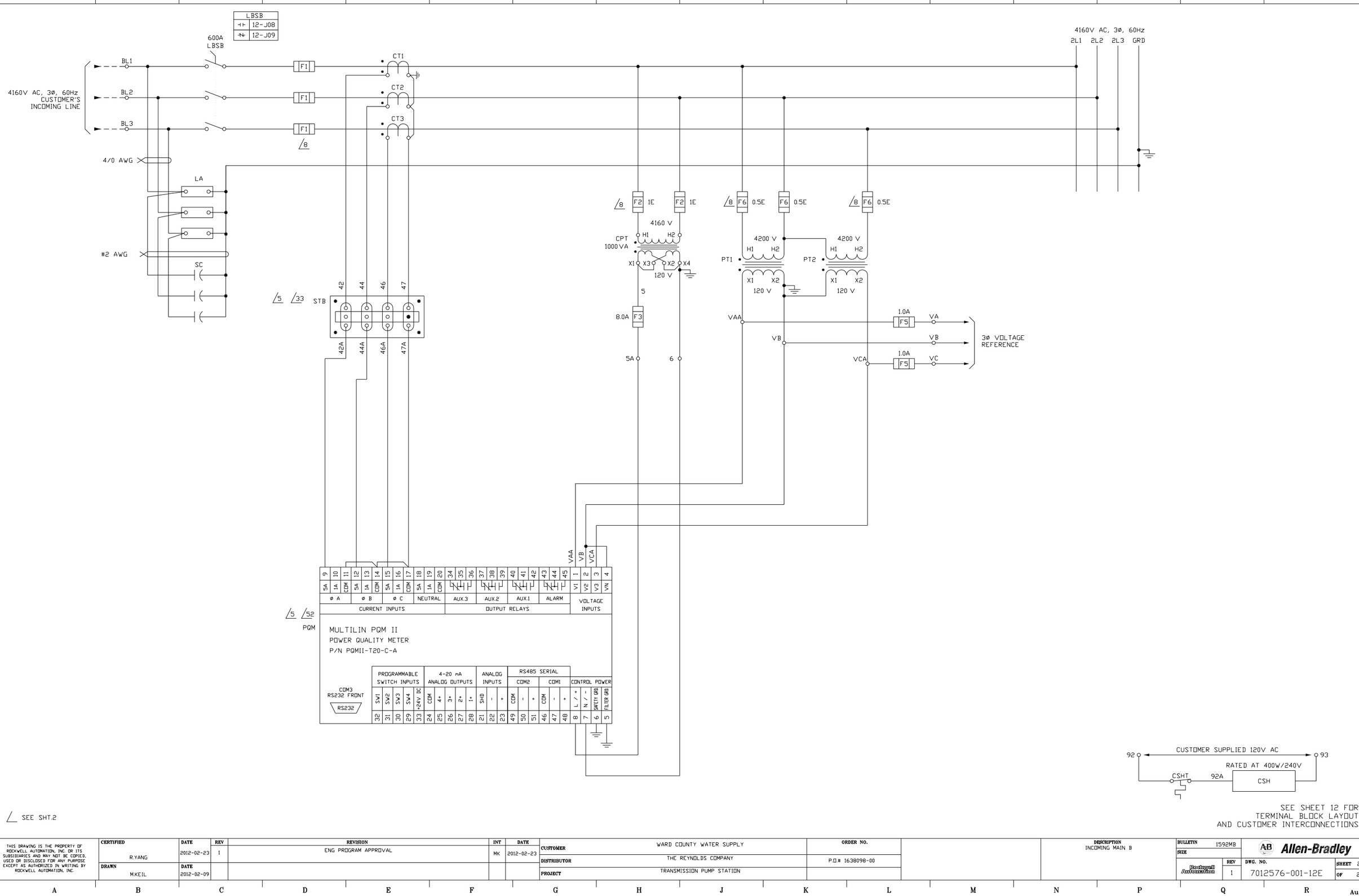
Rockwell Automation

Allen-Bradley

REV 1 DWG. NO. 7012576-001-12E SHEET 20 OF 22

E-DH-C

AutoCAD®



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DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00
PROJECT	TRANSMISSION PUMP STATION	

DESCRIPTION: INCOMING MAIN B

BULLETIN 1592MB | SIZE | REV 1 | DWG. NO. 7012576-001-12E | SHEET 21 OF 22

Rockwell Automation | Allen-Bradley

E-DH-C AutoCAD®

WIRING

CONDUCTOR, OR CONDUCTIVE PATH	OR	
CONDUCTOR, ASSOCIATED OR FUTURE (NOT SUPPLIED BY ROCKWELL AUTOMATION)	OR	
TEMPORARY WIRING		
COPPER BUS BAR		
MECHANICALLY CONNECTED		
CABLE, MULTICONDUCTOR	4 NEMA	4 IEC
CONDUCTOR, CROSSING OF PATHS OR CONDUCTORS NOT CONNECTED	NEMA	IEC
CONDUCTOR, JUNCTION OF CONNECTED PATHS, CONDUCTORS OR WIRES	NEMA	IEC
CONDUCTOR, SHIELDED SINGLE OR MULTICONDUCTOR	NEMA	IEC
CONDUCTORS, TWISTED	NEMA	IEC
WIRE GAUGE MARKER	6	
CONNECTOR, SEPARABLE OR JACKS ENGAGED	NEMA	IEC
TERMINAL	NEMA	IEC
TERMINAL (ROCKWELL AUTOMATION USE ONLY)		
TERMINAL BLOCKS — BARRIER E - END BARRIER	E NEMA	IEC
WIRED TO / FROM DESTINATION (ARROW DIRECTION RELATIVE TO FLOW OF DRAWING ONLY)	2-A01 OR 2-A01 ZONE SHEET	

SWITCHES AND INPUT DEVICES

SWITCH, SINGLE THROW	NEMA	IEC
SWITCH, TOGGLE (MAINTAINED POSITION) TRANSFER, SINGLE POLE	DOOR INTERLOCK NEMA	IEC
PUSHBUTTON NORMALLY OPEN (MAKE) / NORMALLY CLOSED (BREAK)	NEMA	IEC
SWITCH, MUSHROOM HEAD, (MAINTAINED)	NEMA	IEC
CONTACT NORMALLY OPEN (MAKE) / NORMALLY CLOSED (BREAK)	NEMA	IEC
OPENING TIME DELAY CONTACT NORMALLY OPEN (MAKE) / NORMALLY CLOSED (BREAK)	NEMA	IEC
CLOSING TIME DELAY CONTACT NORMALLY OPEN (MAKE) / NORMALLY CLOSED (BREAK)	NEMA	IEC
SWITCH, FLOW - ACTUATED, CLOSES ON INCREASE IN FLOW	NEMA	IEC
SWITCH, LIQUID LEVEL ACTUATED (FLOAT) CLOSING ON RISING LEVEL	NEMA	IEC
SWITCH, PRESSURE OR VACUUM OPERATED CLOSING ON RISING PRESSURE	NEMA	P IEC
SWITCH, TEMPERATURE ACTUATED, OPENING ON RISING TEMPERATURE	NEMA	IEC
SWITCH, SELECTOR (MULTIPOSITION) WITH CONTACT CLOSED INDICATOR X - INDICATES CONTACTS CLOSE	NEMA	1 2 IEC
SWITCH, SELECTOR (MULTIPOSITION) WITH PUSHBUTTON TYPE CONTACT MECHANISM X - INDICATES CONTACTS CLOSED	NEMA	1 2 3 IEC
PLC INPUT	IN NEMA	

OUTPUT DEVICES

COIL, OPERATING	NEMA	IEC
COIL, BLOWOUT	NEMA	
FAN (3ø INDUCTION MOTOR)	NEMA	F 3~ IEC
FAN (1ø INDUCTION MOTOR)	NEMA	F 1~ IEC
INDUCTION MACHINE	NEMA	M 3~ IEC
INDUCTION MACHINE (SYNCHRONOUS)	NEMA	MS 3~ IEC
LIGHT, INDICATING (PILOT, SIGNALLING, OR SWITCHBOARD)	NEMA	IEC
LIGHT, INDICATING PUSH-TO-TEST	NEMA	IEC
LIGHT, INDICATING (LED TYPE)	NEMA	IEC
METER (✱: METER'S FUNCTION)	NEMA	✱ IEC
RECEPTACLE	NEMA	
PLC OUTPUT	OUT NEMA	
GENERATOR	NEMA	

RESISTORS, CAPS, WINDINGS AND GROUND

CAPACITOR	NEMA	IEC
RESISTOR, GENERAL	NEMA	IEC
RESISTOR, ADJUSTABLE (POTENTIOMETER)	NEMA	IEC
REACTOR, SATURABLE CORE	DC WINDING NEMA	IEC
WINDING	NEMA	IEC
TRANSFORMER, WITH MAGNETIC CORE	NEMA	IEC
TRANSFORMER, CURRENT	NEMA	IEC
HALL EFFECT CURRENT SENSOR	+ M − NEMA	+ M − IEC
GROUND ✱✱ PE - EARTH GROUND SG - SAFETY GROUND TE - SIGNAL GROUND	✱✱	IEC
FERRITE		
GROUNDING BALL		

POWER ELECTRONIC DEVICES

DIODE, SEMICONDUCTOR	NEMA	IEC
RECTIFIER SILICON CONTROLLED	NEMA	IEC
SYMMETRICAL GATE-COMMUTATED THYRISTOR AND GATE DRIVER BOARD	NEMA	IEC
RECTIFIER, FULL WAVE BRIDGE	NEMA	IEC

PROTECTION

CIRCUIT BREAKER, CONTROL/POWER	NEMA	IEC
FUSE, CONTROL/POWER	NEMA	IEC
OVERLOAD RELAY, THERMAL	NEMA	IEC
SURGE SUPPRESSOR	SS NEMA	
SWITCH, DISCONNECT (FUSED)	NEMA	
SWITCH, DISCONNECT (NON FUSED)	NEMA	
VARISTOR	NEMA	U IEC
THERMOCOUPLE	NEMA	IEC
HEATSINK	NEMA	

MISCELLANEOUS

IEEE NUMBER FOR PROTECTIVE DEVICE	#
KEY INTERLOCK ON ISOLATION SWITCH OR BREAKER	K
KEY INTERLOCK ON MV DOOR	K
NOTE NUMBER INDICATOR	/#
SWITCH ON 1 2 - INDICATES SWITCH POSITION OFF	ON 1 2
CONTACT LOCATION DESCRIPTION	RELAY 11 02-A01 CONTACT TYPE SHEET ZONE
RELAY LOCATION DESCRIPTION	02-A01 SHEET ZONE

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DRAWN M.KEIL	DATE 2012-02-09				

CUSTOMER	WARD COUNTY WATER SUPPLY	ORDER NO.	
DISTRIBUTOR	THE REYNOLDS COMPANY	P.O.# 1638098-00	
PROJECT	TRANSMISSION PUMP STATION		

DESCRIPTION: SYMBOL TABLE

BULLETIN | SIZE | REV 1 | DWG. NO. 7012576-001-12E | SHEET 22 OF 22

Rockwell Automation — Allen-Bradley

E-DH-C

AutoCAD®

Ward County Water Supply
Transmission Pump Station

Preliminary Bill of Materials
Incoming Main

Unit Location: 1A/2A, 8A/9A
Series Number: 7012576-001-12, 7012576-005-12
ED Number: 7012576-001-12E
DD Number: 7012576-001-12D
Catalog No: 1592MB-BDED-6B-6PT-6T-84D1-804-5010D-5053-6001D-6002

Part No.	Part Description	Qty
80022-154-03	CPT,1KVA,4200:115/230,50/60HZ	1
80253-324-51	1-CPT 110/120V ASSY COMP'NTS	1
80006-316-01	DANGER LABEL LIVE CIRC. ENG.	1
80154-736-52	18" MV DOOR SPEC PAINT T1	1
80253-066-53	GASKETING FOR 18" DOORS	1
80253-175-51	LABEL KIT,5KV "DR" - ENGLISH	1
H-17350	NAMEPLATE WHITE BLANK	1
PQMII	PQMIIT20CA	1
80010-900-96	STAMPING INSTRUCTNS,FUSE LABEL	1
80025-239-01	1E 4800V 5" FUSE A480T1E	2
80025-296-11	FUSE:BOLT-ON-A051B3DAR0-57X	3
80026-428-02	SURGE ARR DIST CLASS 6KV RMS	3
80026-444-02	SURGE ARR STN CLASS 6KV RMS	3
80144-789-02	600AMP LBS KEY ASSY "OFF"	1
80153-275-53	STR HTR ASSY W/T-STAT 400W	1
80157-371-63	18" BARRIER ASSY	1
80158-254-52	HANDLE COVER PLATE ASSY-SPEC.	2
80178-214-51	ASSY INST. LIGHTNING ARRST MTG	1
80178-215-51	MTG ASSY DIST CL LA 600A LBS	1
80253-006-52	18" CAB. ASSY. SPEC. PNT.	1
80253-228-51	LV BARRIER ASSY	1
80255-003	ASSY INSTRU. 18" INC. SER. B	1
LABKITREQD FA	LABEL KIT REQUIRED "FA"	1
80253-174-51	LABEL KIT,5KV "FA" - ENGLISH	1
80253-176-51	LABEL KIT,5KV "PL" - ENGLISH	1
1492-FB1M30	MIDGET FUSE HLDER,1 1/2"X13/32	3
1492-J4	IEC ONE-CIRCUIT FEED-THROUGH B	32
80025-211-01	SHORTING TERMNL BLOCK (4-POLE)	1
80145-871-52	(2)1A ATM FUSE ASSY	2
80253-229-51	18" LV PANEL ASSY STD SCREWS	1
80255-066	LV PANEL ASSY 18"/36"INCOM	1
F-22013	1492 TERMINAL BLOCK BARRIER	1
H-17731	TB N/P FOR LIVE TERMINALS	1
LABKITREQD PL	LABEL KIT REQUIRED "PL"	1
80145-851-53	MV TRANSFORMER MTG PLATE ASSY	1
80178-046-53	MV POTENTIAL TRANSFORMER ASSY	1
80178-046-57	MV POTENTIAL TRANSFORMER ASSY	1
80149-626-53	DOOR 600A LBS MAIN BE SPL PT	1
80253-066-58	GASKETING, FOR 36" 1560 DOOR	1
80253-178-51	LABEL KIT,5KV "DR" - ENGLISH	1
25172-551-02	0.5E 4800V 5" FUSE A480T1/2E	3
40259-304-54	THERMOSTAT & STRIP HEATER ASSY	1

80025-420-04	600AMP LBS LINE AT BOT W AUX	1
80144-773-01	INTERLOCK ASSY.	1
80145-442-56	RHSIDEPL 600A MAIN BE SPEC PT	1
80157-615-02	STRIP HEATER BARRIER	1
80178-408	600A LBS ASSY INSTRUCTIONS	1
80178-409-51	600A LBS B/O MAIN FUSE MNTG	1
80185-261-53	600:5 CT ASSY - INCOMER	1
80253-142-64	CAB PARTS-60LBS MAIN/BOTT BOLT	1
LABKITREQD FA	LABEL KIT REQUIRED "FA"	1
80253-177-51	LABEL KIT,5KV "FA" - ENGLISH	1

Ward County Water Supply
Transmission Pump Station

Preliminary Bill of Materials
VFD Feeder

Unit Location: 3A/3B, 7A/7B
Series Number: 7012576-002-12, 7012576-006-12
ED Number: 7012576-001-12E
DD Number: 7012576-001-12D
Catalog No: 1512BD-ADE-1OFF-1ON-3-4OFFG-4ONR-6B-6T-84D7-803-3950S-4010-5010D

Part No.	Part Description	Qty
80022-154-03	CPT,1KVA,4200:115/230,50/60HZ	1
80253-055-53	(1)CPT UNDER 2KVA TOP CELL 2H	1
80253-324-51	1-CPT 110/120V ASSY COMP'NTS	1
40011-079-13	LEGEND PLATE "HAND-OFF-AUTO"	1
40011-079-32	LEGEND PLATE "ON"	2
80006-253-01	DANGER LABEL AUTO-START ENG	1
80006-316-01	DANGER LABEL LIVE CIRC. ENG.	1
80011-027-05	LEGEND PLATE "OFF"	2
80025-779-01	MULTILIN BLOCKING & TEST MODUL	1
80123-009-51	MECH LATCH TRIP BUTTON ASSY	1
80153-591-74	MV DOOR ASSEMBLY (2-UNIT STR.)	1
80253-066-55	GASKETING FOR 36" 2HI DOORS	1
80253-150-51	LABEL KIT,5KV - DR - ENGLISH	1
80253-359-55	PILOT LIGHTS/DEVICES LED ASSY	1
80253-359-60	PILOT LIGHTS/DEVICES LED ASSY	1
80253-361-51	800H PUSHBUTTONS	1
80253-361-52	800H PUSHBUTTONS	1
80253-362-51	SELECTOR SWITCH ASSEMBLY	1
H-17350	NAMEPLATE WHITE BLANK	1
SR350	350EP5G5HESNNSNDN	1
40266-515-01	20A CARTRIDGE ASSY. 700-CPM	4
80010-900-76	STAMPING INSTRUCTNS,FUSE LABEL	1
80025-239-01	1E 4800V 5" FUSE A480T1E	2
80025-296-10	FUSE:BOLT-ON-A051B1DARO-19R	3
80144-886-56	MECHANICAL DOOR INTERLOCK ASSY	1
80153-479-02	VACUUM CONTACTOR MTG. PLATE	1
80153-646-53	THERMOSTAT & HEATER ASSY.	1
80154-132-60	TRANSFORMER & BRACE ASSY.	1
80154-544-51	400A MOULDED ISOLATOR SW B/O	1
80157-982-51	HANDLE MODULE ASSEMBLY	1
80158-002-53	RH SIDEPLATE ASSY.(2 UNIT STR)	1
80158-908-52	400A ML SER E INTELLIVAC CONT.	1
80158-975-57	DONUT CT 300:5 RATIO TOP	1
80253-004-52	CABINET ASSY (2HI)	1
80253-015-51	TRAILER FB BOLT TYPE FUSES	1
80253-020-52	DONUT CT PWR WIRE 4/0 TOP EXIT	1
80253-100-51	BAR ASSY 1512B T/T EXIT 2 UNIT	1
80255-002	CAB ASSY INSTRUCTIONS 1512-B	1
LABKITREQD FA	LABEL KIT REQUIRED "FA"	1
80253-149-51	LABEL KIT,5KV FA - ENGLISH	1

80253-151-51	LABEL KIT,5KV PL - ENGLISH	1
1492-FB1M30	MIDGET FUSE HLDER,1 1/2"X13/32	3
1492-J4	IEC ONE-CIRCUIT FEED-THROUGH B	43
80006-047-10	2A 250V FUSE LABEL	1
80006-047-33	8A 250V FUSE LABEL	1
80018-529-56	1512B PC WIRE HARNESS(TEW)	1
80098-973-09	BUL.1503 INTVAC+ 400A M/L	1
80145-871-52	(2)1A ATM FUSE ASSY	1
80158-824-52	SC LV TEST SWT ENG.	1
80178-370-52	CONTACTOR CTRL MOD INTELLIVAC	1
80253-058-51	LV ASSEMBLY 2HI	1
80255-062	LV PANEL ASSY INSTR 1512-B	1
F-22013	1492 TERMINAL BLOCK BARRIER	2
H-17731	TB N/P FOR LIVE TERMINALS	2
LABKITREQD PL	LABEL KIT REQUIRED "PL"	1
X-251083	2 AMP 250V MINI FUSE TRM2	1
X-251094	8 AMP 250V MINI FUSE TRM 8	1

Ward County Water Supply
Transmission Pump Station

Preliminary Bill of Materials
XFMR Feeder

Unit Location: 4B, 6B
Series Number: 7012576-003-12, 7012576-007-12
ED Number: 7012576-001-12E
DD Number: 7012576-001-12D
Catalog No: 1512BT-TDE-1OFF-1ON-3-4OFFG-4ONR-6B-6T-84D7-803-3950S-4010-5010D-5051

Part No.	Part Description	Qty
80022-154-03	CPT,1KVA,4200:115/230,50/60HZ	1
80253-055-51	(1)CPT UNDER 2KVA BOT CELL 2H	1
80253-324-51	1-CPT 110/120V ASSY COMP'NTS	1
40011-079-13	LEGEND PLATE "HAND-OFF-AUTO"	1
40011-079-32	LEGEND PLATE "ON"	2
80006-253-01	DANGER LABEL AUTO-START ENG	1
80006-316-01	DANGER LABEL LIVE CIRC. ENG.	1
80011-027-05	LEGEND PLATE "OFF"	2
80025-779-01	MULTILIN BLOCKING & TEST MODUL	1
80123-009-51	MECH LATCH TRIP BUTTON ASSY	1
80153-591-74	MV DOOR ASSEMBLY (2-UNIT STR.)	1
80253-359-55	PILOT LIGHTS/DEVICES LED ASSY	1
80253-359-60	PILOT LIGHTS/DEVICES LED ASSY	1
80253-361-51	800H PUSHBUTTONS	1
80253-361-52	800H PUSHBUTTONS	1
80253-362-51	SELECTOR SWITCH ASSEMBLY	1
H-17350	NAMEPLATE WHITE BLANK	1
SR350	350EP5G5HESNNSNDN	1
26152-103-02	2.5" CABLE CLAMP &BAR,2C1-250X	1
40266-515-01	20A CARTRIDGE ASSY. 700-CPM	4
80010-901-06	100E GOULD FUSE LABEL INSTR	1
80025-200-06	FUSE/CLIP-ON-A055F1D0R0-100E	3
80025-239-01	1E 4800V 5" FUSE A480T1E	2
80153-479-02	VACUUM CONTACTOR MTG. PLATE	1
80153-646-53	THERMOSTAT & HEATER ASSY.	1
80154-132-67	TRANSFORMER & BRACE ASSY.	1
80154-516-51	400A MOULDED ISOLATOR SW C/0	1
80157-982-51	HANDLE MODULE ASSEMBLY	1
80157-983-53	KEY INTERLOCK ASSY."F" (OFF)	1
80158-908-52	400A ML SER E INTELLIVAC CONT.	1
80158-975-64	DONUT CT 100:5 RATIO BOTT	1
80253-014-51	TRAILER FB CLIP TYPE FUSES	1
80253-022-52	#2 PWR WIRE DONUT CT BOT EXIT	1
1492-FB1M30	MIDGET FUSE HLDER,1 1/2"X13/32	3
1492-J4	IEC ONE-CIRCUIT FEED-THROUGH B	43
80006-047-10	2A 250V FUSE LABEL	1
80006-047-33	8A 250V FUSE LABEL	1
80018-529-56	1512B PC WIRE HARNESS(TEW)	1
80098-973-09	BUL.1503 INTVAC+ 400A M/L	1
80145-871-52	(2)1A ATM FUSE ASSY	1

80158-824-52	SC LV TEST SWT ENG.	1
80178-370-52	CONTACTOR CTRL MOD INTELLIVAC	1
80253-058-51	LV ASSEMBLY 2HI	1
80255-062	LV PANEL ASSY INSTR 1512-B	1
F-22013	1492 TERMINAL BLOCK BARRIER	2
H-17731	TB N/P FOR LIVE TERMINALS	2
X-251083	2 AMP 250V MINI FUSE TRM2	1
X-251094	8 AMP 250V MINI FUSE TRM 8	1

Ward County Water Supply
Transmission Pump Station

Preliminary Bill of Materials
Tie Breaker

Unit Location: 5A
Series Number: 7012576-008-12
ED Number: 7012576-001-12E
DD Number: 7012576-002-12D
Catalog No: 1594T-BDED-5053

Part No.	Part Description	Qty
80149-622-53	DOOR 600A LBS MAIN TE SPL PT	1
80253-066-58	GASKETING, FOR 36" 1560 DOOR	1
80253-178-51	LABEL KIT,5KV "DR" - ENGLISH	1
80253-290-51	DOOR LUBRICANT APPLICATION	8
H-17350	NAMEPLATE WHITE BLANK	1
80025-420-03	600AMP LBS LINE AT TOP	1
80144-773-01	INTERLOCK ASSY.	1
80144-789-02	600AMP LBS KEY ASSY "OFF"	1
80145-443-56	RHSIDEPL 600A MAIN TE SPEC PT	1
80255-104	600AMP LBS ASSY INSTRU DRAWING	1
LABKITREQD FA	LABEL KIT REQUIRED "FA"	1
80253-177-51	LABEL KIT,5KV "FA" - ENGLISH	1

Part Number	Description	Total Qty
Spare Parts Furnished as per Spec 26 13 23, 3.08		
A. 6 - spare fuses of each type and size including MV fuses for each pump station		
80145-871-52-R	(2)1A ATM FUSE ASSY	6
X-251083-R	2 AMP 250V MINI FUSE TRM2	6
X-251094-R	8 AMP 250V MINI FUSE TRM 8	6
25172-551-02-R	0.5E 4800V GOULD 5" FUSE	6
80025-200-06-R	FUSE/CLIP-ON-A055F1D0R0-100E	6
80025-239-01-R	FUSE,1E 4800V GOULD 5"	6
80025-296-10-R	FUSE: BOLT-ON A051B1DARO-19R	6
B. 6 - spare lamps of each type and size		
800T-N318G	6V FULL VOLTAGE LED GREEN	2
800T-N318R	6V FULL VOLTAGE LED RED	2

C. 2 - sets of each type of test cable
Not Applicable

D. 2 - sets of each type of special wrench or tool for primary disconnecting devices
Not Applicable

E. 1 - elevating table type lifting device for installation of contactors
Not Applicable

F. 1 - spare relay and timer of each type
Not Applicable

PQM II

POWER QUALITY METER

Power Quality and
Energy Cost Management

KEY BENEFITS

- Power quality metering with waveform capture and historical data logging
- Easy to program and use with keypad and large illuminated 40 character display
- Multiple communication ports for integration with DCS and SCADA systems
- Supports DNP 3.0 and Modbus protocols
- Digital and analog I/Os for control and alarms
- Voltage disturbance recording capability for electrical sag and swell events.

APPLICATIONS

- Metering of distribution feeders, transformers, generators, capacitor banks and motors
- Medium and low voltage systems
- Commercial, industrial, utility
- Flexible control for demand load shedding, power factor, etc.

FEATURES

Monitoring and Metering

- Ia Ib Ic In
- Va Vb Vc Vab Vbc Vca
- V I unbalance
- True PF crest and K factor
- Hz W var VA
- Wh varh VAh W cost
- Demand: A W var VA
- Harmonic analysis through 63rd with THD and TIF
- Event recorder - 150 events
- Waveform capture
- Data logger -98,000 events
- Voltage Disturbance Recorder (VDR) -500 events

Communications

- Front RS232 serial port (1,200 to 19,200 bps)
- Two rear RS485 serial ports with ModBus and DNP 3.0 protocol
- Ethernet connectivity provided by MultiNet
- EnerVista™ software is provided for setup and monitoring functions
- External dial-in modem capabilities

Protection & Control

- Load shedding
- Power factor control
- Pulse input totalizing

Introduction

GE Multilin has set a new standard in metering technology with the introduction of the PQM II. This meter, designed on the latest industry specifications, provides accurate and reliable three-phase power metering with an optional Ethernet and fiber communications module in a small and modern package. The PQM II can be used for a variety of applications including metering of distribution feeders, transformers, generators and motors.

Robust Metering and Power Quality Capabilities in One Package

The PQM II is an ideal choice when continuous monitoring of a three phase system is required. It provides metering for current, voltage, real and reactive power, energy use, cost of power, power factor and frequency. Waveform capture and Voltage Disturbance Recorder continuously monitors power quality. Programmable setpoints and 4 assignable output relays allow control functions to be added for specific applications.

Communications Made Easy

Integrate process, instrumentation and electrical requirements in a plant automation system by connecting PQM II meters to a DCS or SCADA system. Meter provides multiple communication ports that can provide data simultaneously to multiple masters such as SCADA, DCS, BMS etc. Meter supports both ModBus and DNP 3.0 protocol. A computer running EnerVista™ software can change system setpoints, monitor values, status and alarms. Continuous monitoring minimizes process downtime by immediately identifying potential problems due to faults or changes.

Industry leading software makes setup simple

The PQM II comes complete with EnerVista™ GE Multilin's suite of software tools for managing the entire lifecycle implementation of the PQM II. EnerVista™ contains all of the tools for setting up and configuring your PQM II in minutes via RS232, RS485, external modem or Ethernet LAN.

Ethernet capability

With the optional Multinet module, users can add Ethernet capability to their meter. Multinet is an Ethernet communications module that allows connection of up to 30 ModBus devices, providing ModBus TCP/IP communications for these devices over Ethernet. This allows connection to Fiber Optic LAN and WAN systems for remote access to data on the PQM II.

Standard Features

The PQM II provides continuous monitoring of a three-phase system. It provides metering of current, voltage, real and reactive power, energy use, cost of power, power factor and frequency. Ethernet communications are available through the optional Multinet module.

Metering

PQM II is a true RMS meter with 0.2% accuracy for voltage and currents. The PQM II provides advanced features for monitoring and metering which include:

- Ia Ib Ic In
- Va Vb Vc Vab Vbc Vca
- V I unbalance
- True PF crest and K factor
- Hz W var VA
- Wh varh VAh W cost
- Demand: A W var VA

Keypad and illuminated 40 character display provides local setpoint settings and monitoring of values and status.

Mounting Versatility

PQM II panel mount with display, offers an easy local interface. Standard models have RS485 communications for programming and monitoring. Users can replace expensive additional devices by-adding the CONTROL, TRANSDUCER and POWER analysis options to the PQM II as required.

Alarms

Any of the assignable outputs may be used to trigger an alarm for specific applications. Simple alarm messages provide easy notification.

CONDITION	APPLICATION
overcurrent	motors/transformers
undercurrent	pumps/compressors
neutral current	leakage/unbalance
current unbalance	motors
overvoltage	equipment protection
undervoltage	motors/load transfer
phase sequence	pumps/equipment
overfrequency	generators
underfrequency	load shedding
power factor	capacitor banks
switch input	process control

Connect up to 32 ModBus devices to your Ethernet network

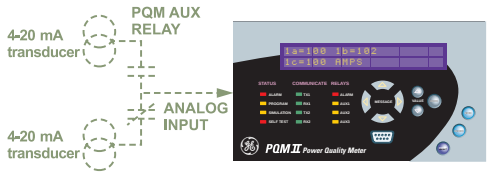
Communications

Integrate process, instrumentation and electrical requirements in a plant automation system by connecting PQM II meters to a DCS or SCADA system. Initially PQM II meters can be used as stand-alone units. Open architecture allows connection to other ModBus® compatible devices on the same communication link. At a later stage PQM II can be integrated in a complete plant wide system for overall process monitoring and control.

The standard PQM II comes complete with a rear RS485 and front RS232 port. RS232 port can be used for data collection, printing reports or problem analysis without disturbing the main RS485 communication interface at rear. The standard meter provides:

- RS485 ModBus® 1,200 to 19,200-bps
- DNP 3.0 Level 2 Protocol
- Mini RTU SCADA system component
- Measure actual values
- Read status
- Issue control commands
- Load all setpoints from a file
- Change individual setpoints

A computer running EnerVista™ software can change system setpoints, monitor values, status and alarms. Continuous monitoring minimizes process downtime by immediately identifying potential problems due to faults or changes.



Connect two 4 to 20 mA transducers for process variable measurement and control.

Future Expansion

The PQM II uses non-volatile flash memory for firmware storage. This allows future product upgrades to be loaded via the serial port. Upgrades can also be downloaded from the GE Multilin website.

Options

There are a variety of options available to the user, allowing a range of custom configurations:

Transducer

Four Analog Outputs: Four isolated analog outputs can be used to replace eight analog transducers. Output signals can be selected from any of the measured parameters for direct interface to a PLC or other devices.

Analog Input: PQM II meter can accept two analog inputs from external devices. Meter can be programmed to activate a control relay based on analog input from transducers (temperature, level etc.)

Communications

Second Rear Comm Port: An additional rear RS485 comm port is provided for simultaneous monitoring by process, instrument, electrical or maintenance personnel.

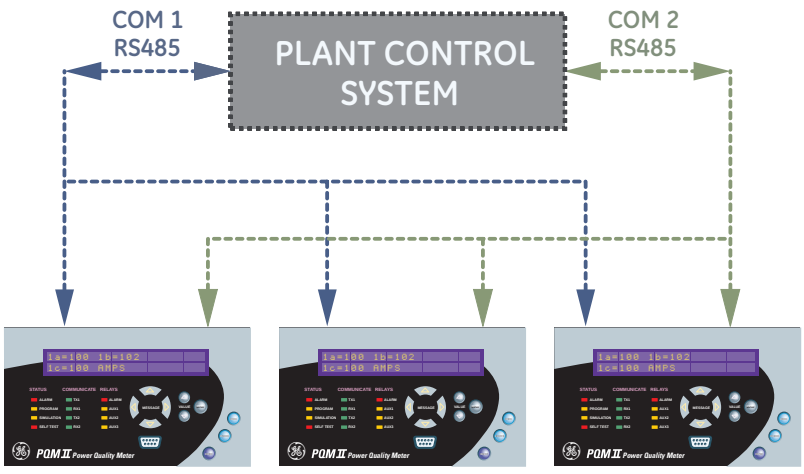
Control

Three output relays and four inputs allow measured parameters from the standard PQM II to be combined with setpoints and I/Os for control applications. With the control option, three output relays and four switch inputs are added along with programmable setpoints to make a mini RTU. Output relays can also be controlled via the communication port or assigned to different setpoints for custom programming to accommodate many applications such as:

- Undercurrent alarm for pumps
- Over and undervoltage for generators
- Unbalance alarm for rotating machines
- Dual level power factor for capacitor bank switching
- Underfrequency/demand output for load shedding resulting in power cost savings
- kWh, kvarh and kVAh pulse output for PLC interface

Power Analysis

Data Logger (Trending): Trending is useful as a troubleshooting aid when a problem is detected. Measured values can be selected and plotted with a programmable sampling rate to suit the time interval of interest. The generated chart recorder screen can be printed or



Redundancy in high security systems is provided by the 2nd RS485 comm port.

exported to other programs for report writing.

Harmonic Analysis: Non linear loads such as variable speed drives, computers and electronic ballasts can cause harmonics which may lead to problems such as nuisance breaker tripping, telephone interference, transformer, capacitor or motor overheating. Harmonic analysis can be used for fault diagnosis such as detecting undersized neutral wiring, need for a harmonic rated transformer, or effectiveness of harmonic filters. Details of the harmonic spectrum are useful and available with the power analysis option.

Voltage Disturbance Recorder (VDR)
The Voltage Disturbance Recorder (VDR) function adds to the PQM II the ability to monitor and record Sag and Swell disturbances. It can record up to 500 sag/swell events for all voltages simultaneously.

Waveform Capture: Voltage and current waveforms can be captured and displayed on a PC using the EnerVista™ program supplied with the PQM II or using third party software. Distorted peaks or notches from SCR switching provide clues for taking corrective action.

Event Recorder: Alarms, setpoint triggers, input and output events can be stored in a 150 event record and time and date stamped by the internal clock. This is useful for diagnosing problems and system activity. Minimum and maximum values are also continuously updated and time stamped.

Trace Memory: The PQM II can be configured to record a maximum of 36 cycles of data on all voltage and current inputs based on overvoltage, undervoltage, overcurrent or switch input state change.

EnerVista™ Software

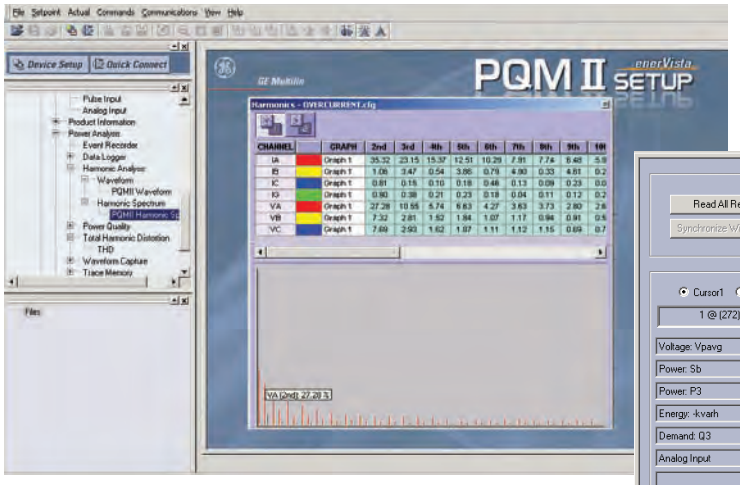
EnerVista™ Launchpad

EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining GE Multilin Products. Launchpad allows configuration of devices in real-time by communicating using RS232, RS485, Ethernet, or modem connections.

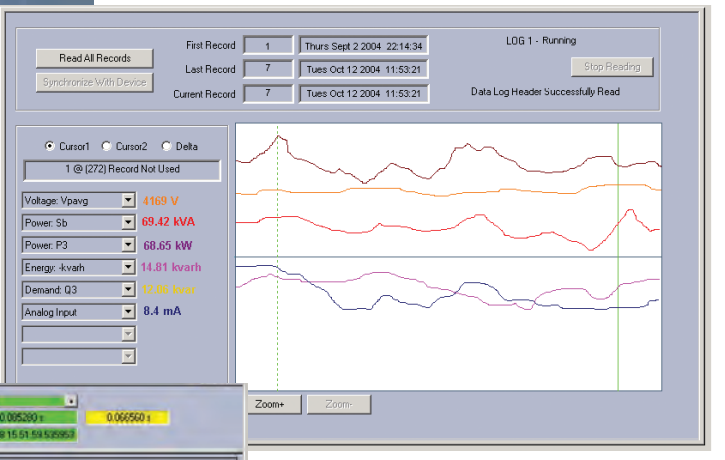
The intuitive user interface makes it simple to enter setpoints, read metered values, monitor status and evaluate power quality. Powerful troubleshooting features make it easy to retrieve and view voltage & current waveshapes and harmonic analysis. This vital information can help provide early warning of problems and prevent equipment damage or nuisance breaker tripping.

EnerVista Launchpad PQM II Setup and Analysis

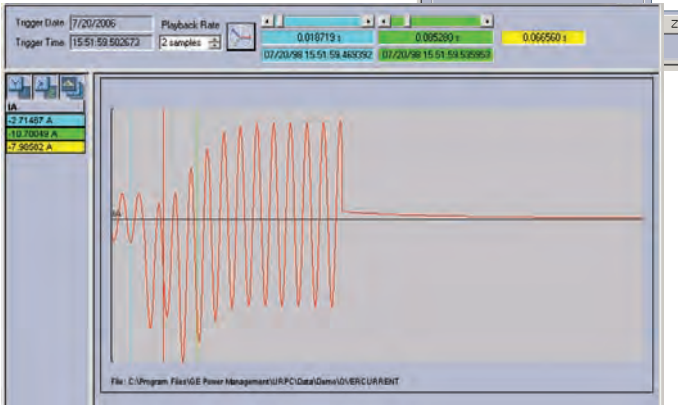
PQM II setup program contains many tools and reports that simplify device configuration and allows viewing of power system events.



Simplified IED Setup



Record trends of measured parameters over time



Voltage and current waveforms provide valuable insights into system problems

Included in Launchpad is a document archiving and management system that ensures critical documentation is up-to-date and available when needed by automatically checking for and downloading new versions of manuals, applications notes, specifications, and service bulletins.

Viewpoint Monitoring

Viewpoint Monitoring is a simple-to-use, full-featured monitoring and data recording software package for small systems. Viewpoint Monitoring provides a complete HMI package that instantly puts critical real-time device data on your PC through pre-configured graphical screens with the following functionality.

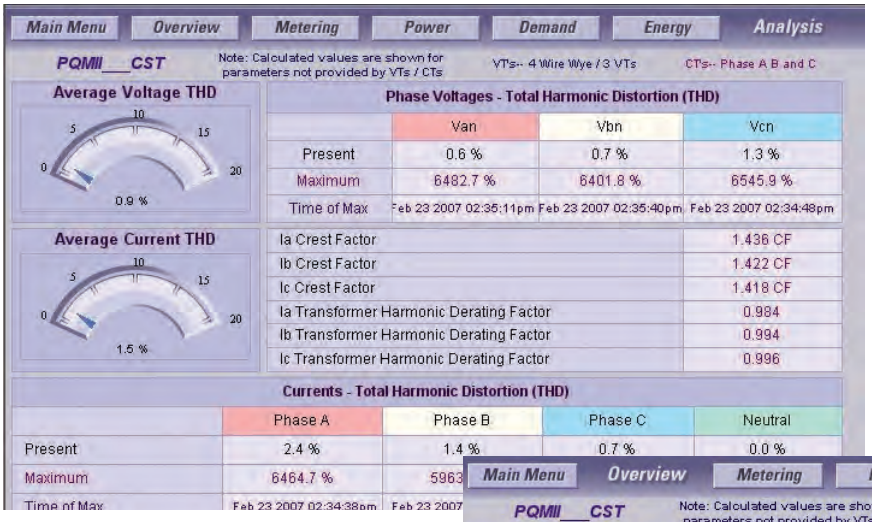
- Plug-&-Play Device Monitoring
- System Single-Line Monitoring & Control
- Annunciator Alarm Screens
- Trending Reports
- Automatic Event Retrieval
- Automatic Waveform Retrieval

EnerVista™ Integrator

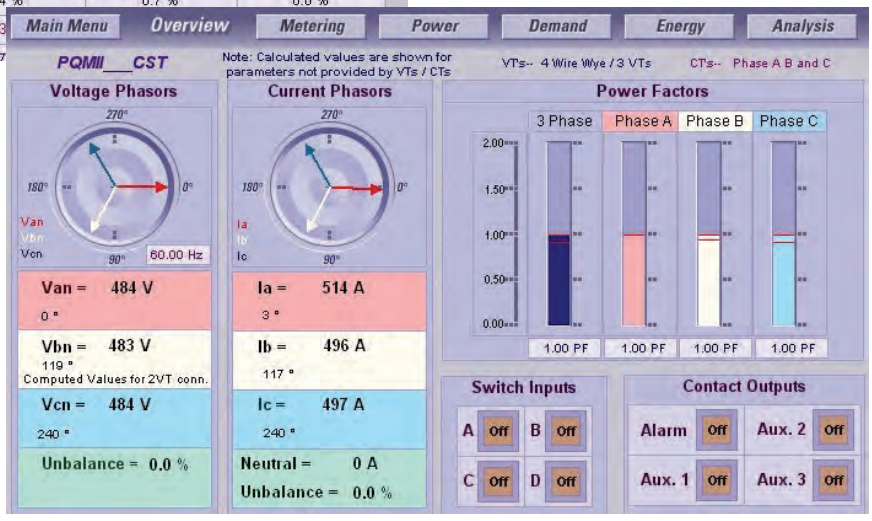
EnerVista™ Integrator is a toolkit that allows seamless integration of GE Multilin devices into new or existing automation systems by sending GE device data to HMI, DCS, and SCADA systems. Included in EnerVista Integrator is:

- OPC/DDE Server
- GE Multilin Drivers
- Automatic Event Retrieval
- Automatic Waveform Retrieval

EnerVista Viewpoint Monitoring Plug-and-Play Screens



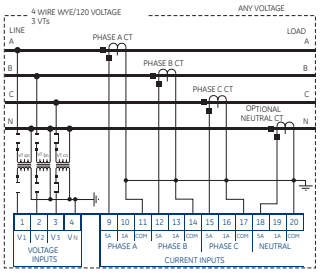
Viewpoint Monitoring PQM II analysis screen for detailed power quality information



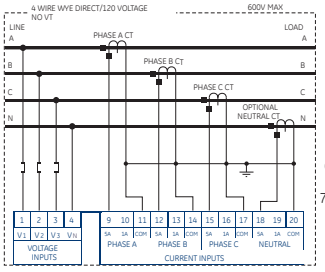
Viewpoint Monitoring PQM II real-time overview screen for detailed device status

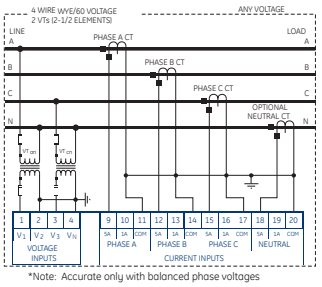
Typical Wiring

ALTERNATIVE CT/VT CONNECTIONS

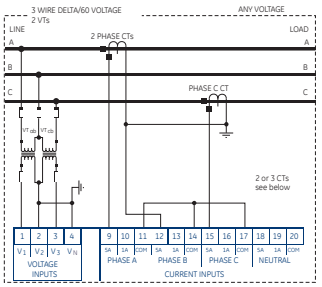


Perferrred 4 wire configuration

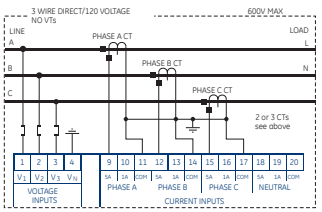


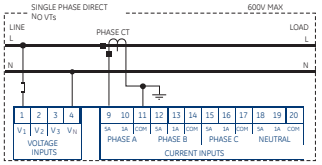


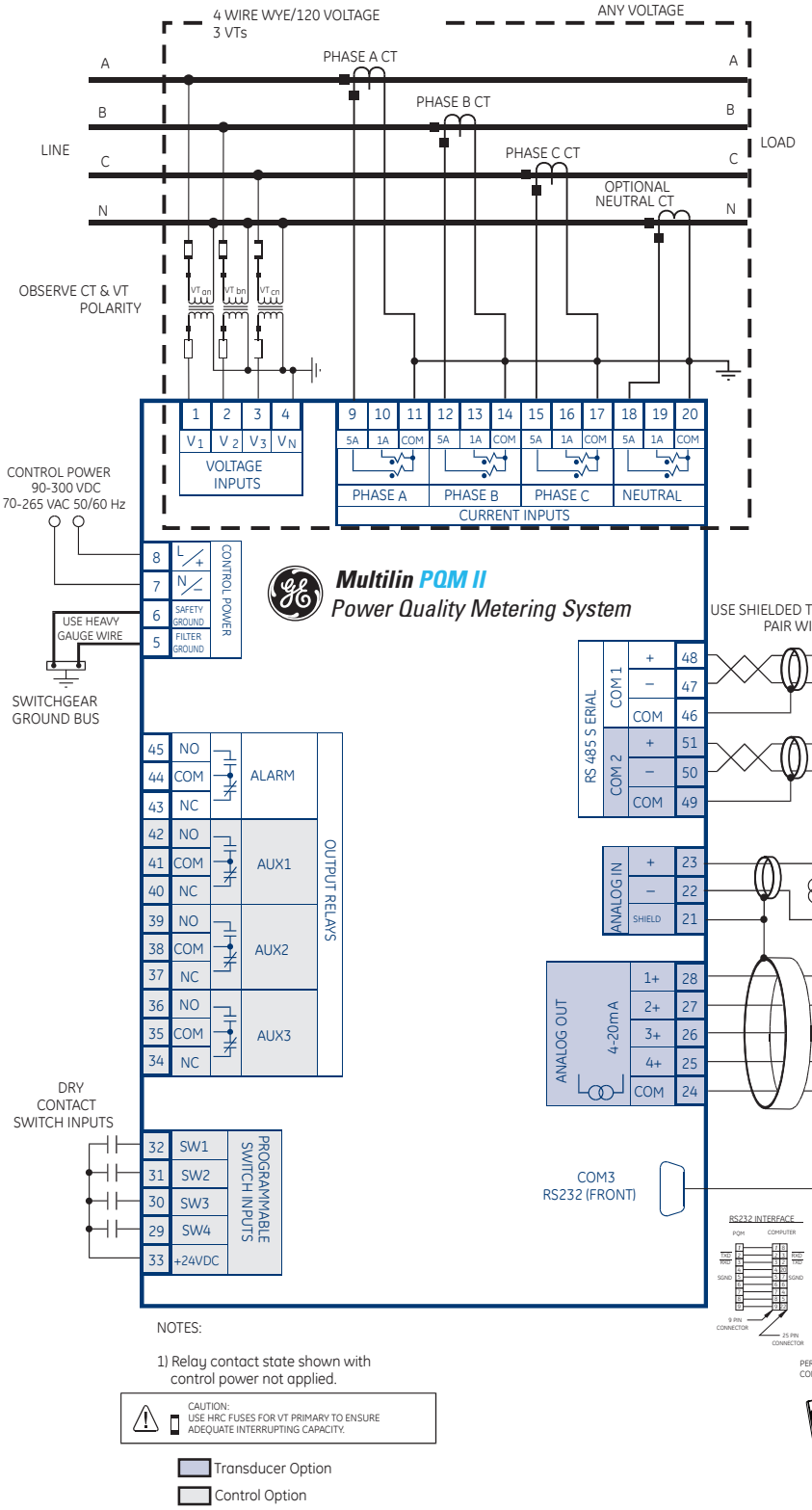
*Note: Accurate only with balanced phase voltages



Preferred 3 wire configuration







NOTES:

1) Relay contact state shown with control power not applied.

CAUTION:
USE HRC FUSES FOR VT PRIMARY TO ENSURE ADEQUATE INTERRUPTING CAPACITY.

Transducer Option

Control Option

Technical Specifications

MONITORING

UNDERVOLTAGE MONITORING

Required voltage: 20 V applied
Pickup level: 0.50 – 0.99 in steps of 0.01 x VT
Dropout level: 103% of pickup
Time delay: 0.5 – 600.0 in steps of 0.5 sec
Phases: Any one/any two/all three (programmable) phases have to go below pickup to operate
Level accuracy: Per voltage input
Timing accuracy: -0/+1 sec

OVERVOLTAGE MONITORING

Pickup level: 1.01 – 1.25 in steps of 0.01 x VT
Dropout level: 97% of pickup
Time delay: 0.5 – 600.0 in steps of 0.5 sec
Phases: Any one/any two/all three (programmable) phases have to exceed pickup to operate
Level accuracy: Per voltage input
Timing accuracy: -0/+1 sec

UNDERFREQUENCY MONITORING

Required voltage: 20 V applied
Pickup level: 20 – 70.00 in steps of 0.01 Hz
Dropout level: Pickup +0.03 Hz
Time delay: 0.1 – 10.0 in steps of 0.1 sec
Level accuracy: ±0.02 Hz
Timing accuracy: ±3 cycles

OVERFREQUENCY MONITORING

Required voltage: 20 V applied
Pickup level: 20 – 70.00 in steps of 0.01 Hz
Dropout level: Pickup -0.03 Hz
Time delay: 0.1 – 10.0 in steps of 0.1 sec
Level accuracy: ±0.02 Hz
Timing accuracy: ±3 cycles

POWER FACTOR MONITORING

Required voltage: 20 V applied
Pickup level: 0.50 lag – 0.50 lead in steps of 0.01
Dropout level: 0.50 lag – 0.50 lead in steps of 0.01
Time delay: 0.5 – 600.0 in steps of 0.5 sec
Timing accuracy: -0/+1 sec

SAMPLING MODES

	SAMPLES/ CYCLE	INPUTS SAMPLED AT A TIME	DURATION (CYCLES)
Metered values	64	ALL	2
Trace memory	16	ALL	continuous
Harmonic spectrum	256	1	1

DEMAND MONITORING

Measured values: Phase A/B/C/N current (A)
3f real power (kW)
3f reactive power (kvar)
3f apparent power (kVA)
Measurement type: Thermal exponential
90% response time (programmable):
5 – 60 min, steps of 1 min
Block interval/rolling demand time in interval
(programmable): 5 – 60 min, steps of 1 min
Pickup level: A: 10 – 7,500 in steps of 1
kW: 0.1 – 6,500.0 in steps of 0.1
kvar: 0.1 – 6,500.0 in steps of 0.1
kVA: 0.1 – 6,500.0 in steps of 0.1

METERING

MEASURED VALUES

PARAMETER	ACCURACY (% of full scale)	RESOLUTION	RANGE
Voltage	±0.2%	1 VOLT	20% of VT – 100% of VT
Current	±0.2%	1 A	1% of CT – 150% of CT
Voltage unbalance	±1%	0.1%	0 – 100.0%
Current unbalance	±1%	0.1%	0 – 100.0%
kW	±0.4%	0.01 kW	0 – 999,999.99 kW
kvar	±0.4%	0.01 kvar	0 – 999,999.99 kvar
kVA	±0.4%	0.01 kVA	0 – 999,999.99 kVA
kWh	±0.4%	1 kWh	2^{32} kWh
kvarh	±0.4%	1 kvarh	2^{32} kvarh
kVAh	±0.4%	1 kVAh	2^{32} kVAh
Power factor	1%	0.01	±0.0 – 1.0
Frequency	0.02 Hz	0.01 Hz	20.00 – 70.00 Hz
kw demand	±0.4%	0.1 kw	999,999.99 kw
kvar demand	±0.4%	0.1 kvar	999,999.99 kvar
kva demand	±0.4%	0.1 kva	999,999.99 kva
Amps demand	±0.2%	1 A	0 – 7,500 A
Amps THD	±2.0%	0.1%	0.0 – 100.0%
Volts THD	±2.0%	0.1%	0.0 – 100.0%
Crest factor	±0.4%	—	1 – 9.99

INPUTS

AC CURRENT

Conversion: True RMS, 64 samples/cycle
CT input: 1 A and 5 A secondary
Burden: 0.2 VA
Overload: 20 x CT for 1 sec
100 x CT for 0.2 sec
Full scale: 150% of CT
Frequency: up to 32nd harmonic
Accuracy: ±0.2% of full scale, true RMS

AC VOLTAGE

Conversion: True RMS, 64 samples/cycle
VT pri/sec: Direct or 120 – 72,000 : 69 – 240
Input range: 20 – 600 VAC
Full scale: 150/600 VAC autoscaled
Burden: <0.1 VA
Frequency: up to 32nd harmonic
Accuracy: ±0.2% of full scale, true RMS

SWITCH INPUTS

Type: Dry contact
Resistance: 1,000 ž max ON resistance
Voltage: 24 VDC @ 2 mA
Duration: 100 ms minimum

ANALOG INPUT

Range: 4 – 20 mA
Accuracy: ±1% of full scale
Relay output: Programmable 4 – 20 mA
Internal burden resistance: 250 ž

PULSE INPUT

Max inputs: 4
Min pulse width: 150 ms
Min off time: 200 ms

COMMUNICATIONS

COM1/COM2 type: RS485 2-wire, half duplex, isolated
COM3 type: RS232, 9PIN
Baud rate: 1,200 – 19,200 bps
Protocol: ModBus® RTU and DNP 3.0 level 2
Functions: Read/write setpoints
Read actual values
Execute commands

POWER SUPPLY

CONTROL POWER

Input: 90 – 300 VDC
70 – 265 VAC 50/60 Hz
Power: 10 VA nominal, 20 VA maximum
Holdup: 100 ms typical @ 120 VAC/VDC

ENVIRONMENTAL

Operating Temperature: -10C to +60C
Humidity: operating up to 95% (non condensing) @ 55C
Pollution Degree: 2
Ingress Protection: IP40 (front), IP20 (back)

PACKAGING

Shipping box: 8 1/2" L x 6" H x 6" D
(215 mm x 152 mm x 152 mm)
Ship weight: 5 lbs (2.3 kg)
NOTE: LCD contrast impaired below -20° C

OUTPUTS

ANALOG OUTPUTS

Accuracy: ±1% of full scale reading

	OUTPUT	
	0 – 1 mA (T1 Option)	4 – 20 mA (T20 Option)
Max load	2400 Ω	600 Ω
Max output	1.1 mA	21 mA

Isolation: ± 36 VDC isolated, active source

OUTPUT RELAYS

Voltage	Make/Carry Continuous	Make/Carry 0.2 SEC	Break
30 VDC	5	30	5
Resistive 125 VDC	5	30	0.5
250 VDC	5	30	0.3
30 VDC	5	30	5
Inductive 125 VDC	5	30	0.25
(Vr = 7ms) 250 VDC	5	30	0.15
120 VAC	5	30	5
Resistive 250 VAC	5	30	5
Inductive 120 VAC	5	30	5
PF = 0.4 250 VAC	5	30	5
Configuration	FORM C NO/NC		
Contact material	SILVER ALLOY		

PULSE OUTPUT

Parameters: +ve kWh, –ve kWh, +ve kvarh, –ve kvarh, kVAh
Interval: 1 – 65000 in steps of 1
Pulse width: 100 – 2000 ms in steps of 10 ms
Min pulse interval: 500 ms

TYPE TESTS

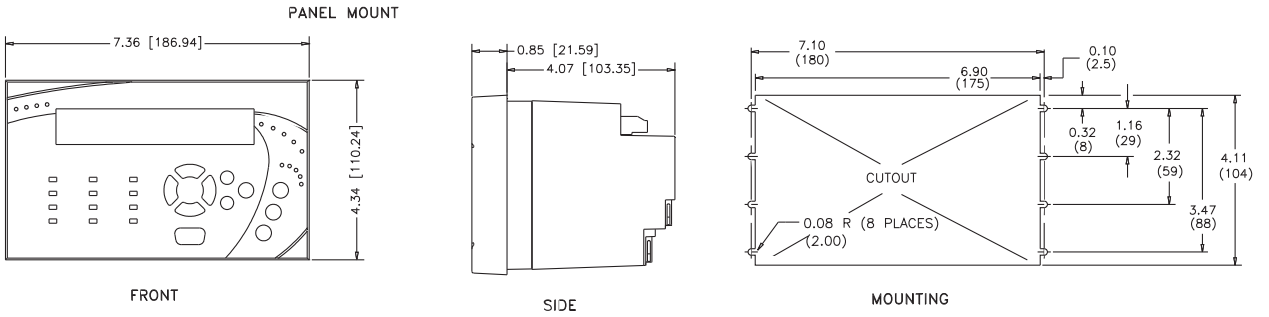
Dielectric voltage withstand:	EN60255-5
Impulse voltage withstand:	EN60255-5
Insulation resistance:	EN60255-5
Damped Oscillatory:	IEC61000-4-18 / IEC60255-22-1
Electrostatic Discharge:	EN61000-4-2 / IEC60255-22-2
RF immunity:	EN61000-4-3 / IEC60255-22-3
Fast Transient Disturbance:	EN61000-4-4 / IEC60255-22-4
Surge Immunity:	EN61000-4-5 / IEC60255-22-5
Conducted RF Immunity:	EN61000-4-6 / IEC60255-22-6
Radiated & Conducted Emissions:	CISPR11 / CISPR22 / IEC60255-25
Sinusoidal Vibration:	IEC60255-21-1
Shock & Bump:	IEC60255-21-2
Power magnetic Immunity:	IEC61000-4-8
Pulse Magnetic Immunity:	IEC61000-4-9
Voltage Dip & interruption:	IEC61000-4-11
Ingress Protection:	IEC60529
Environmental (Cold):	IEC60068-2-1
Environmental (Dry heat):	IEC60068-2-2
Relative Humidity Cyclic:	IEC60068-2-30
EFT:	IEEE / ANSI C37.90.1

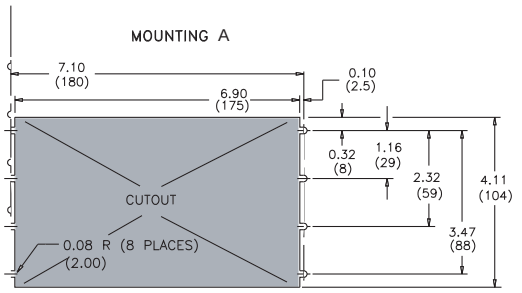
APPROVALS

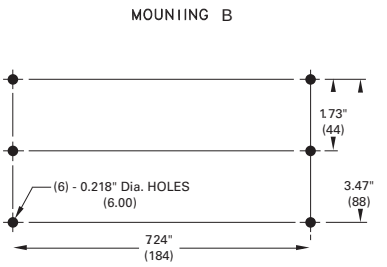
ISO:	Manufactured to an ISO9001 registered program
cULus e83849 NKCR/7:	UL508, UL1053, C22.2.No 14
CE:	EN60255-5, EN61000-6-2

Please refer to the Multilin PQMII Power Quality Meter Instruction Manual for complete technical specifications

PQM II Dimensions







Ordering

PQM II	*	*	*	Description
PQM II				Basic unit with display, all current/voltage/power measurements, 1-RS485 comm port, 1 RS232 comm port
	T20			Transducer option; 4 isolated analog outputs 0 – 20 mA and 4 – 20 mA, assignable to all measured parameters, 4 – 20 mA analog input, 2nd RS485 comm port
	T1			Transducer option; 4 isolated analog outputs 0 – 1 mA, assignable to all measured parameters, 4 – 20 mA analog input, 2nd RS485 comm port
		C		Control option; 3 additional programmable output relays (total of 4), 4-programmable switch inputs
			A	Power analysis option; harmonic analysis, triggered trace memory waveform capture, event record, data logger, voltage disturbance recorder (VDR)

Modifications:

MOD 501:	20 – 60 VDC/20 – 48 VAC control power
MOD 504:	Removable terminal blocks
MOD 525:	Harsh Environments Conformal Coating

Control Power:

90 – 300 VDC/70 – 265 VAC standard
20 – 60 VDC/20 – 48 VAC (MOD 501)

Accessories for the PQM II:

• Multilink Ethernet Switch	ML1600-HI-A2-A2
• Multinet	Multinet-FE
• Viewpoint Monitoring	VP-1

Visit www.GEMultilin.com/PQM II to:

- View Guideform Specifications
- Download the instruction manual
- Review applications notes and support documents
- Buy a PQM II online

Multilin™ 350

FEEDER PROTECTION SYSTEM

Intuitive and Innovative Feeder Protection

KEY BENEFITS

- Easy to use and intuitive overcurrent protection and control for feeder applications.
- Effortless draw-out construction eliminates requirement for test switches and reduces downtime
- Environmental monitoring system to alarm on destructive operating conditions and plan preventative maintenance
- Easy to use interface and set up in one simple step
- Accelerated Life Cycle Tested to ensure reliability of relay operation under abnormal conditions
- Advanced power system diagnostics to increase reliability through fault and disturbance recording capabilities
- Flexible communications with multiple ports & protocols to allow seamless integration into new and existing infrastructure
- Arc flash mitigation via zone inter-tripping, flex curves, and multiple settings group
- Powerful Security Audit Trail tool to increase security and minimize system risks by tracking setting changes
- Application flexibility with the use of programmable logic elements

APPLICATIONS

- Industrial feeders with enhanced breaker monitoring diagnostics, etc.
- Distribution utility down stream breaker protection
- Medium voltage Utility feeders with advanced control features Cold Load Pickup, auto reclose, multiple settings group, etc

FEATURES

Protection and Control

- Phase, neutral and ground TOC and IOC
- Undervoltage, overvoltage, frequency
- Neutral/ground directional
- Negative sequence Overcurrent
- ANSI, IAC, IEC, flex curves
- Cable Thermal Model Protection
- Breaker Failure
- Cold Load Pick Up
- Four-shot auto-reclose
- 8 digital inputs, 7 contact outputs
- Two setting groups

Metering & Monitoring

- Event Recorder: 256 events
- Oscillography with 32 samples per cycle
- IRIG-B clock synchronization
- Relay health diagnostics
- Security audit trail
- Metering - current, voltage, power, frequency

User Interface

- 4 line display for easy viewing of key data
- 10 LED indicators for quick diagnostics
- Front USB and rear RS485 serial communications
- Multiple Communication Protocols:
  IEC 61850
  IEC 61850 GOOSE,
  MODBUS TCP/IP, MODBUS RTU,
  DNP 3.0, IEC 60870-5-104, IEC 60870-5-103

EnerVista™ Software

- EnerVista Software- an industry-leading suite of software tools that simplifies every aspect of working with Multilin devices.
- Quick & easy configuration requiring minimal settings for most feeder applications.

Overview

The 350 relay is a member of the 3 Series family of Multilin relays. This protective device is used to perform primary circuit protection on medium voltage feeders and down stream protection for distribution utilities.

The basic protection function of this relay includes multiple phase, ground, and neutral time and instantaneous overcurrent elements for coordination with upstream and downstream devices. Additionally, the device provides essential feeder breaker control features such as cold load pick up blocking, breaker failure, and auto reclose.

The robust 350 streamlines user work flow processes and simplifies engineering tasks such as configuration, wiring, testing, commissioning, and maintenance. This cost-effective relay also offers enhanced features such as diagnostics, preventative maintenance, arc flash mitigation and security.

Easy to Use

Drawout Construction

The 350 offers a complete drawout feature eliminating the need for rewiring after testing has been concluded. The withdrawable feature also eliminates the need to open the switch gear door and disconnect communication cables, eg. Ethernet fiber, copper, RJ45, etc prior to removing the relay from the chasis

Effortless Retrofit

The small and compact 350 enables multiple relays to be mounted side by side on medium voltage panels. It also allows easy retrofit into existing S1 and S2 cutouts with adapter plates.

Easy to Configure

Fast & Simple Configuration

The 350 requires minimal settings for configuring standard feeder protection applications. The entire feeder protection setup can be completed in one easy step.

Advanced Communications

Easy integration into new or existing infrastructure

With several Ethernet and serial port options, and a variety of protocols, the 350 provides advanced and flexible communication selections for new and existing energy management, SCADA, and DCS systems.

Easy to Use and Configure

Easy to Configure- 1 simple step

Advanced & Flexible Communication Options

Easy to Use- Draw out case

Diagnostic Alarms

Enhanced Diagnostics

Preventative Maintenance

The 350 allows users to track relay exposure to extreme environmental conditions by monitoring and alarming at high ambient temperatures. This data allows users to proactively schedule regular maintenance work and schedule upgrade activities. The diagnostics data enables the user to understand degradation of electronics due to extreme conditions.

Cost Effective

Robust Design

The 350 is subjected to Accelerated Life Testing (ALT) to validate accurate relay function under specified normal conditions. The device is further tested for durability through Highly Accelerated Life Testing (HALT) where it undergoes extreme operating conditions. The robust 350 design ensures long term operation.

Reduced Life Cycle Cost

The 350 is designed to reduce total installation and life cycle cost for feeder protection. The draw out construction of the device reduces downtime during maintenance and decreases extra wiring needed for relay testing and commissioning.

Multiple Options

Several option for protection & communications are provided to match basic to high end application requirements.

Protection

The 350 feeder protection system offers protection, control and monitoring in one integrated, economical and compact package.

Timed Overcurrent (Phase, Ground, Neutral)

The 350 has three-phase TOC elements which enables coordination with upstream and downstream protection devices such as fuses, overload relays, etc to maximize fault selectivity and minimize interruptions and downtime.

Multiple time current curves are available including IAC, IEC, ANSI and IEEE curves. Additional user programmable flex curves can be used to customize and meet specific coordination requirements. The TOC has both linear and instantaneous reset timing function to coordinate with electro-mechanical relays

Instantaneous Overcurrent (Phase, Ground, Neutral)

The instantaneous element provides fast clearance of high magnitude faults to prevent damage to the power infrastructure and the equipment connected to it.

Neutral Overcurrent

The neutral signal is derived as the residual sum of the three phase CTs eliminating the need for an additional ground sensor.

Sensitive Ground Overcurrent

Sensitive ground protection feature detects ground faults on high impedance grounded systems in order to limit damage to conductors and equipment. Special low ratio CT's are used for this purpose to detect low magnitude ground faults.

Over/Under Voltage Protection

Overvoltage / Undervoltage protection features can cause a trip or generate an alarm when the voltage exceeds a specified voltage setting for a specified time.

Frequency Protection

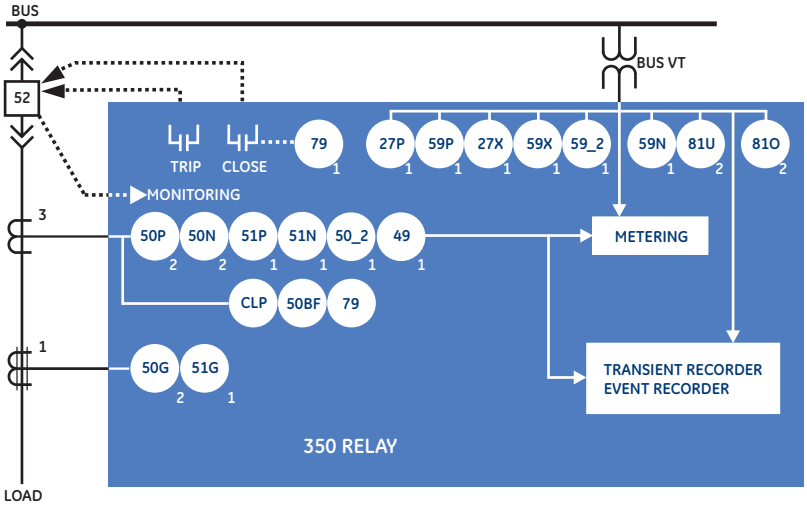
The 350 offers overfrequency and underfrequency elements to improve network (grid) stability using voltage or frequency based load shedding techniques.

It also provides back up protection when protecting feeders and other frequency sensitive power equipment.

Arc Flash Mitigation

The 350 relay is equipped with multiple setting groups and two user definable inverse curves -FlexCurves A and B for fast and reliable arc-flash mitigation and breaker operation. In the event of an arc-

Protection Features

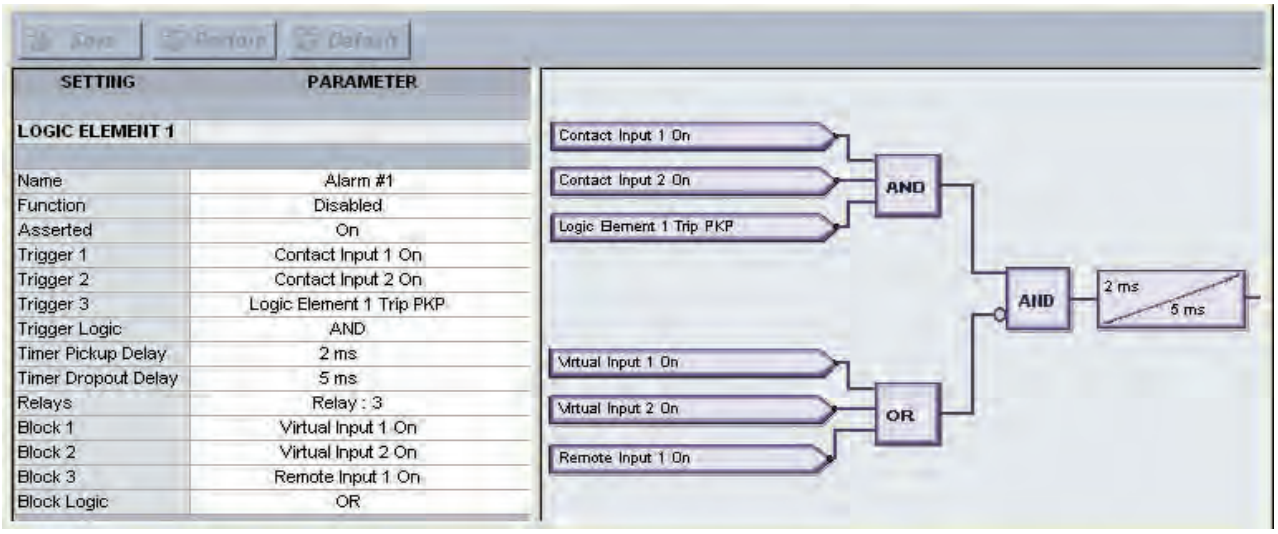


ANSI Device Numbers & Functions

Device Number	Function
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
49	Thermal Model
50P	Phase Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50G	Ground/Sensitive Ground Instantaneous Overcurrent
50BF	Breaker Failure
50_2	Negative Sequence Overcurrent
51P	Phase Timed Overcurrent
51G	Ground Timed Overcurrent
51N	Neutral Timed Overcurrent
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59N	Neutral Overvoltage
59_2	Negative Sequence Overvoltage
67G	Ground Directional Overcurrent
67N	Neutral Directional Overcurrent
79	Autoreclose
81U	Underfrequency
81O	Overfrequency
CLP	Cold Load Pickup

Latched Lockout available as a standard feature

Logic Designer



Sixteen logic elements available for applications such as manual control, interlocking, and peer to peer tripping.

flash, the relay can be set to communicate to any upstream or downstream devices via IEC 61850 GOOSE messaging.

Cable Thermal Model

The cable thermal modelelement protects feeder cables against overheating due to excessive load. It estimates the temperature rise of current carrying conductors based on the amount of current flow (I2R) and alarms when temperature rise exceeds a threshold value. This protection feature is essential to ensure the longevity of electrical feeders; particularly important to prevent premature cable failures, expensive repair costs and system down time.

Neutral/Ground Directional Overcurrent

The directional ground overcurrent isolates faulted feeders in ring bus or parallel feeder arrangements. It also allows detection of back feed of fault current from feeders with motors.

Control

Cold Load Pick Up

Cold Load Pick up allows automatic or manual blocking or raising of trip settings for a period after the breaker has been closed. This feature adapts the pick up of overcurrent elements to override the higher overload currents resulting from re-energization of feeder after a long period of time.

Breaker Failure

The Breaker Failure function is used to determine when a trip command sent to a breaker has not been executed within a selectable time delay. In the event of a breaker failure, the 350 will issue an additional signal to trip the breakers connected to the same busbar or signal the trip of upstream breakers.

Autoreclose

Reclose can be initiated externally or from an overcurrent protection. Up to four reclose operations are available, each with a programmable dead time. For each reclose shot, the relay can be programmed to block any overcurrent element.

Automation and Integration

Inputs & Outputs

The 350 features the following inputs and outputs for monitoring and control of typical feeder applications:

- 8 contact Inputs with programmable thresholds
- 2 Form A output relays for breaker trip and close with coil monitoring
- 5 Form C output relays

IEC 61850 GOOSE

The 350 supports IEC 61850 Logical Nodes which allows for digital communications to DCS, SCADA and higher level control systems.

In addition, the 350 also supports IEC 61850 GOOSE communication, providing a means of sharing digital point state information between 350's or other IEC 61850 compliant IED's.

- Eliminates the need for hardwiring contact inputs to contact outputs via communication messaging.
- Transmits information from one relay to the next in as fast as 8 ms.
- Enables sequence coordination with upstream and downstream devices.
- When Breaker Open operation malfunctions, GOOSE messaging sends a signal to the upstream breaker to trip and clear the fault.

Logic Elements

The 350 relay has sixteen Logic Elements available for the user to build simple logic using the state of any programmed contact, virtual, remote input or the output operand of a protection or control element.

The logic provides for assigning up to three triggering inputs in an "AND/OR" gate for the logic element operation and up to three blocking inputs in an "AND/OR" gate for defining the block signal. Pickup and dropout timers are available for delaying the logic element operation and reset respectively.

Virtual Inputs

Virtual inputs allow communication devices the ability to write digital commands to the 350 relay. These commands could be open/close the breaker, changing setting groups, or blocking protection elements.

Multiple Settings Group

Two separate settings groups are stored in nonvolatile memory, with only one group active at a given time. Switching between setting groups 1 and 2 can be done by means of a setting, a communication command or contact input activation.

The two settings groups allow users to store seasonal settings- such as for summer and winter or alternate profiles such as settings during maintenance operations.

Monitoring & Diagnostics

Event Recording

Events consist of a broad range of change of state occurrences, including pickups, trips, contact operations, alarms and self test status. The 350 relay stores up to 256 events time tagged to the nearest millisecond. This provides the information required to determine sequence of events which facilitates diagnosis of relay operation. Event types are individually maskable in order to avoid the generation of undesired events, and includes the metered values at the moment of the event.

Oscillography/ Transient Fault Recorder

The 350 captures current and voltage waveforms and digital channels at 32 samples per cycle. Multiple records can be stored in the relay at any given time with a maximum length of 192 cycles Oscillography is triggered either by internal signals or an external contact.

Trip/Close Coil Monitoring

The 350 can be used to monitor the integrity of both the breaker trip and closing coils and circuits. The supervision inputs monitor both the battery voltage level, while the outputs monitor the continuity of the trip and/or closing circuits, by applying a small current through the circuits.

Basic Metering

Metered values include:

- Current: Ia, Ib, Ic, In, Ig, Isg
- Phase-to-phase and phase-to-ground voltages for bus and line: Van, Vbn, Vcn, Vab, Vbc, Vca
- Active power (3-Phase)
- Reactive power (3-Phase)
- Frequency

Advanced Device Health Diagnostics

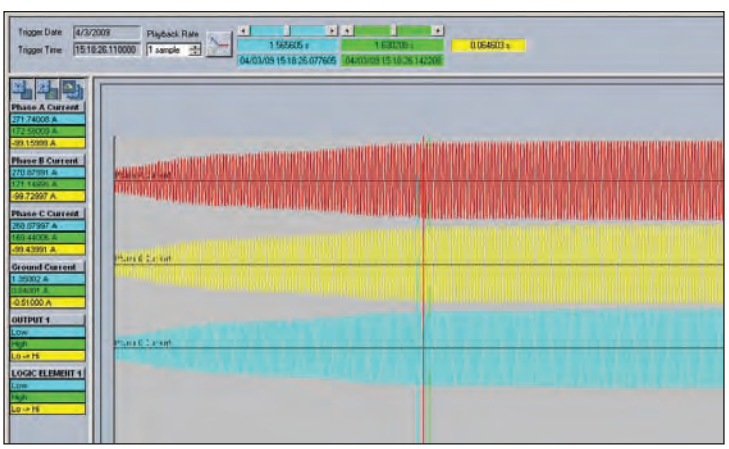
The 350 performs comprehensive device health diagnostic tests during startup and continuously at runtime to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact system reliability. Device status is communicated via SCADA communications and the front panel display. This continuous monitoring and early detection of possible issues helps improve system availability by employing predictive maintenance.

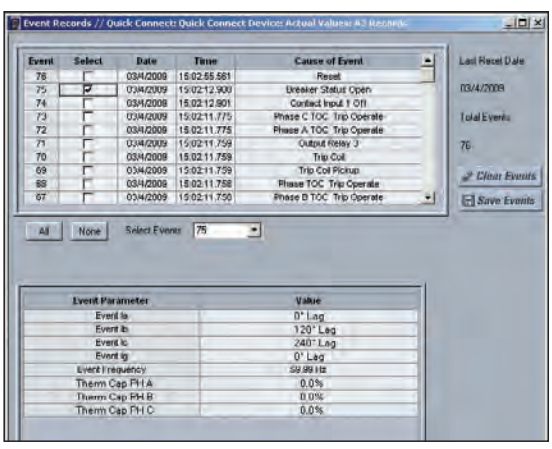
IRIG-B

IRIG-B is a standard time code format that allows time stamping of events to be synchronized among connected devices within 1 millisecond. An IRIG-B input is provided in the 350 to allow time synchronization using a GPS clock over a wide area. The 350 IRIG-B supports both AM and DC time synchronization with an auto detect feature that removes the requirement for manual selection.

Power System Troubleshooting

Analyze power system disturbances with transient fault recorder and event records





Temperature Monitoring

The 350 continually monitors ambient temperature around the relay and alarms when the device is exposed to extreme temperatures and undesirable conditions such as air-conditioning unit or station heater failures.

The EnerVista Viewpoint maintenance tool allows users to review and analyze the time period a 350 relay is exposed to certain temperature ranges.

Security

Security Audit Trail

The Security Audit Trail feature provides complete traceability of relay setting changes at any given time and is NERC CIP compliant. The 350 maintains a history of the last 10 changes made to the 350 configuration, including modifications to settings and firmware upgrades. Security Setting Reports include the following information:

- If Password was required to change settings
- MAC address of user making setting changes
- Listing of modified changes
- Method of setting changes - Keypad, Front serial port, Ethernet, etc.

Password Control

With the implementation of the Password Security feature in the 350 relay, extra measures have been taken to ensure unauthorized changes are not made to the relay. When password security is enabled, changing of setpoints or issuing of commands will require passwords to be entered. Separate passwords are supported for remote and local operators, and separate access levels support changing of setpoints or sending commands.

Advanced Communications

The 350 incorporates the latest communication technologies making it the easiest and the most flexible feeder protection relay for use and integration into new and existing infrastructures. The 350 relay provides the user with one front USB and one rear RS485 communication port. Also available with the 350 is a rear communication port with Ethernet Fiber and Copper. Through the use of these ports, continuous monitoring and control from a remote computer, SCADA system or PLC is possible.

The 350 supports popular industry standard protocols enabling easy, direct integration into electrical SCADA and HMI systems. The protocols supported by the 350 include:

- IEC 61850
- IEC 61850 GOOSE
- DNP 3.0
- Modbus RTU

SECURITY/CHANGE HISTORY REPORT

Generated at: September 15 2010 16:56:05

Device Summary

Device Name:	350
Device Type:	SR 350
Order Code:	350-EP0G0HSSNM2E0N
Firmware Version:	1.20
Serial Number:	BL0A10000019
Communication:	COM 3, 115200

Setting Changes History

Session#	Date of Change	Method of Change	# Of Changes	Password Entered	Changes by Whom IP /Mac	Event Type	Filename	Status	Firm Version
1	09/15/2010 04:40:11 PM	USB	0	Yes	0:0:0:0	Setpoint File		Relay Not Ready	120
2	09/15/2010 04:41:36 PM	Ethernet	1	Yes	3:13:81:141	Setpoint Change	350_120.sr3 : C:	Relay Not Ready	120
3	09/15/2010 04:44:48 PM	Ethernet	1	Yes	3:13:81:141	Setpoint Change	350_120.sr3 : C:	Relay Not Ready	120
4	09/15/2010 04:46:20 PM	USB	14	Yes	3:13:81:141	Setpoint Change	350_120.sr3 : C:	Relay Not Ready	120
5	09/15/2010 04:54:39 PM	USB	6	Yes	3:13:81:141	Setpoint Change	350_120.sr3 : C:	Relay Ready	120

Setting Changes Detail History

Session#	Date Of Change	Old Value	New Value	Data Item	Modbus Address
2	09/15/2010 04:41:36 PM	1	1	Config Revision Number	0X1266
3	09/15/2010 04:44:48 PM	1	1	Config Revision Number	0X1266
4	09/15/2010 04:46:20 PM	50	5	Ground CT Primary	0X10e
4	09/15/2010 04:51:46 PM	0	64	DataSet Item 1	0X126d
4	09/15/2010 04:51:46 PM	0	102	DataSet Item 2	0X126f
4	09/15/2010 04:51:46 PM	0	103	DataSet Item 3	0X1271
4	09/15/2010 04:51:46 PM	0	130	DataSet Item 4	0X1273

GE Multilin EnerVista VIEWPOINT maintenance

Trace any setting changes with security audit trail

- Modbus TCP/IP
- IEC 60870-5-103
- IEC 60870-5-104

These protocols make it easy to connect to a Utility or Industrial automation system, eliminating the need for external protocol converter devices.

EnerVista™ Software

The EnerVista™ suite is an industry leading set of software programs that simplifies every aspect of using the 350 relay. The EnerVista suite provides all the tools to monitor the status of the protected asset, maintain the relay, and integrate the information measured into DCS or SCADA monitoring systems. Convenient COMTRADE and sequence of event viewers are an integral part of the 350 set up software and are included to ensure proper protection and system operation.

Simplified Feeder Setup

The 350 Feeder Protection System includes a simplified setup process. This simplified feeder setup consists of minimal settings and can be accessed through the relay front panel or via the EnerVista Setup software. Once the information is entered, the simplified setup will generate a settings file, provide documentation indicating which settings are enabled, and an explanation of the parameters entered.

Viewpoint Monitoring

Viewpoint Monitoring is a simple to use and full featured monitoring and data recording software package for small systems. Viewpoint monitoring provides a complete HMI package with the following functionality:

- Plug and play device monitoring
- System single line monitoring and control
- Annunciator alarm screens
- Trending reports
- Automatic event retrieval
- Automatic waveform retrieval

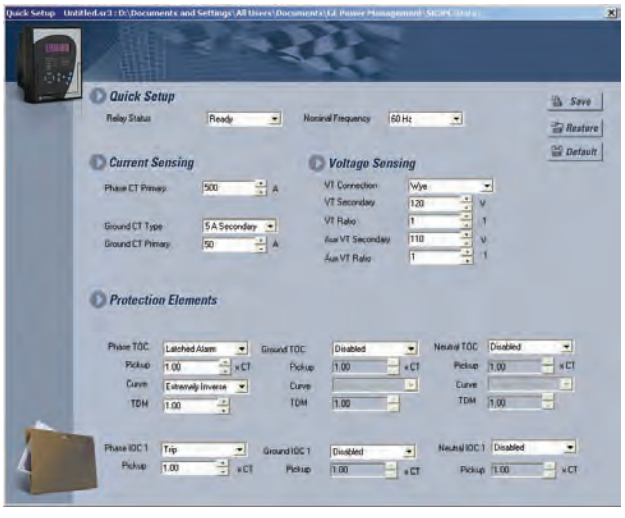
Display

A 4 line liquid crystal display (LCD) allows visibility under varied lighting conditions. When the keypad and display are not being used, the metering summary page is displayed to show critical metered values.

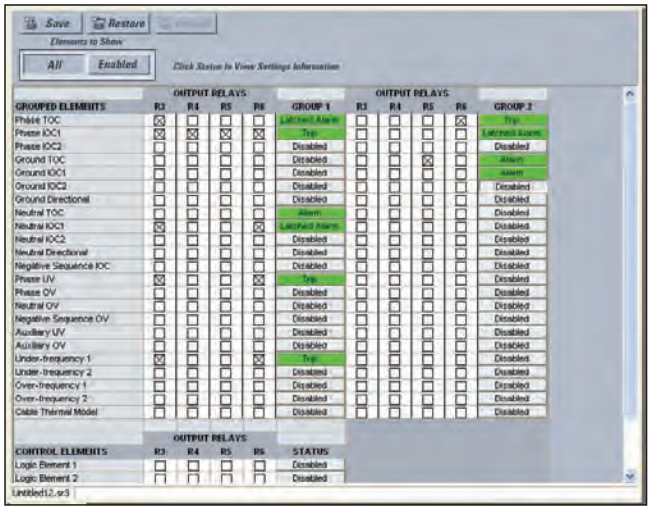
LEDs

The 350 relay has ten LED's that provide status indication for various conditions of the relay and the system. The LED indications are color coded to indicate the type of event.

Feeder protection settings in one easy step

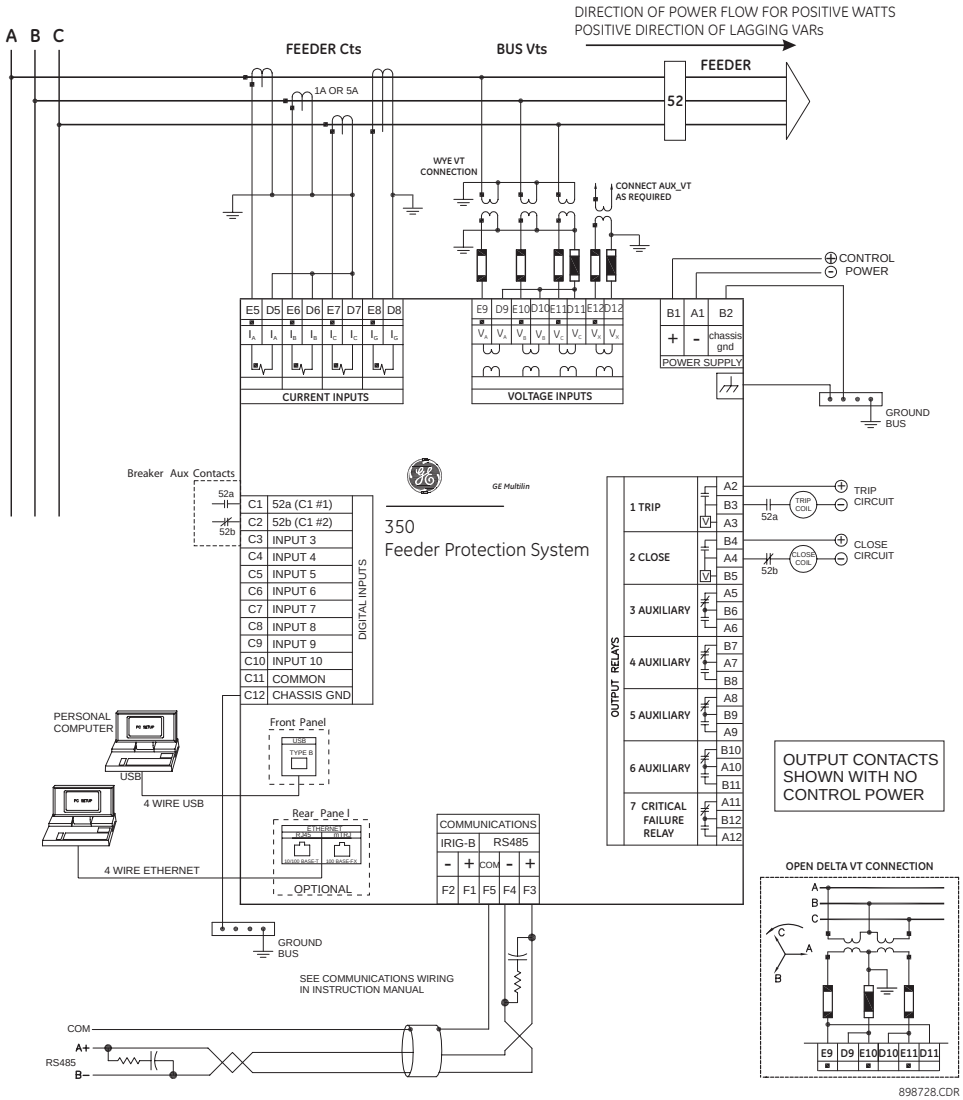


Fast and accurate configuration in one simple screen.

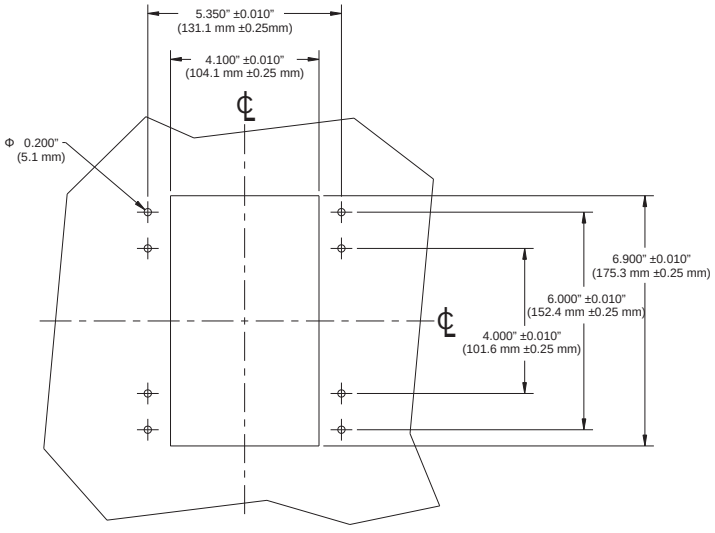


3 Series setup software protection summary for viewing a summary of Protection & Control configuration.

Typical Wiring Diagram



Mounting



User Interface

SETPOINT GROUP 1, 2:
These indicators are continuously on if corresponding group provides settings for protection elements.

TRIP:
Indicator turns on when relay detects a trip condition. Operates the Trip Relay to open the breaker.

ALARM:
While relay detects an alarm condition, indicator flashes.

PICKUP:
Indicator lights steady when any protection feature pickup threshold exceeded.

DISPLAY:
4 line text for easy viewing of key data

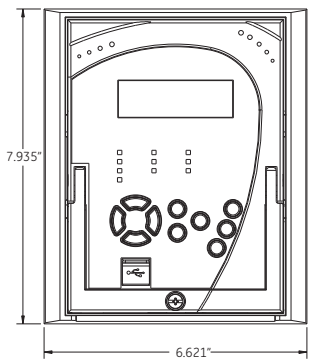
LEDs:
10 LED indicators for quick diagnostics

KEYPAD:
Ten button keypad for access to device interrogation and change of settings.

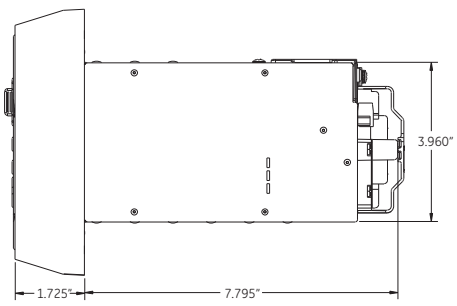
FRONT PORT:
Electrically isolated front USB communication port

Dimensions

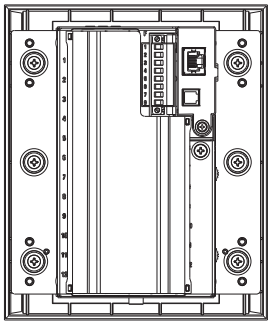
Front



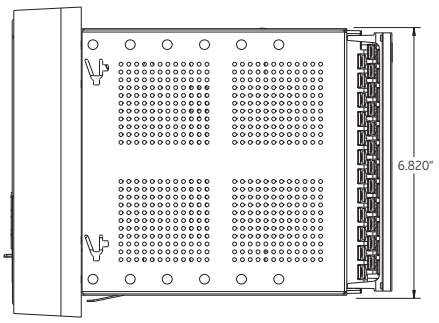
Top



Rear



Side



Technical Specifications

PHASE/NEUTRAL/GROUND TIME OVERCURRENT (51P/51N/51G)

Pickup Level:	0.05 to 20.00 x CT in steps of 0.01 x CT
Dropout Level:	97 to 99% of Pickup @ I > 1 x CT Pickup - 0.02 x CT @ I < 1 x CT
Curve Shape:	ANSI Extremely/Very/Moderately/ Normally Inverse Definite Time (0.05 s base curve) IEC Curve A/B/C/Short IAC Extreme/Very/Inverse/Short User Curve, FlexCurve™ A/B (programmable curves)
Curve Multiplier:	0.05 to 20.00 in steps of 0.01
Reset Time:	Instantaneous, Linear
Time Delay Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater
Level Accuracy:	per CT input

SENSITIVE GROUND TIME OVERCURRENT (51SG)

Pickup Level:	0.005 to 3 x CT in steps of 0.001 x CT
Dropout Level:	97 to 99% of Pickup @ I > 0.1 x CT Pickup - 0.002 x CT @ I < 0.1 x CT
Curve Shape:	ANSI Extremely/Very/Moderately/ Normally Inverse DefiniteTime IEC Curve A/B/C/Short Inverse IAC Extreme/Very/Inverse/Short Inverse User Curve, FlexCurve™ A/B
Curve Multiplier:	0.05 to 20.00 in steps of 0.01
Reset Time:	Instantaneous, Linear
Time Delay Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater
Level Accuracy:	per CT input

PHASE/NEUTRAL/GROUND NEGATIVE SEQUENCE INSTANTANEOUS OVERCURRENT (50P/50N/50G/50_2)

Pickup Level:	0.05 to 20 x CT in steps of 0.01 x CT
Dropout Level:	97 to 99% of Pickup @ I > 1 x CT Pickup - 0.02 x CT @ I <1 x CT
Time delay:	0.00 to 300.00 sec in steps of 0.01
Operate Time:	<30 ms @ 60Hz (I > 2.0 x PKP, No time delay) <35 ms @ 50Hz (I > 2.0 x PKP, No time delay)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	per CT input

SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Pickup Level:	0.005 to 3 x CT in steps of 0.001 x CT
Dropout Level:	97 to 99% of Pickup @ I > 0.1 x CT Pickup - 0.002 x CT @ I < 0.1 x CT
Time delay:	0.00 to 300.00 sec in steps of 0.01
Operate Time:	<30 ms @ 60Hz (I > 2.0 x PKP, No time delay) <35 ms @ 50Hz (I > 2.0 x PKP, No time delay)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	per CT input

GROUND DIRECTIONAL

Directionality:	Co-existing forward and reverse
Operating:	Ground Current (Ig)
Polarizing Voltage:	V_0 calculated using phase voltages (VTs must be connected in "Wye") - V_0 measured from Vaux input. (3V0 provided by an external open delta connection).
MTA:	From 0° to 359° in steps of 1°
Angle Accuracy:	±4°
Operation Delay:	20 to 30 ms

NEUTRAL DIRECTIONAL

Directionality:	Co-existing forward and reverse
Polarizing:	Voltage, Current, Dual
Polarizing Voltage:	V_0 calculated using phase voltages (VTs must be connected in "Wye") - V_0 measured by Vaux input (3V0 provided by an external open delta connection).
Polarizing Current:	Ig
MTA:	From 0° to 359° in steps of 1°
Angle Accuracy:	±4°
Operation Delay:	20 to 30 ms

PHASE/AUXILIARY UNDERVOLTAGE (27P/27X)

Minimum Voltage:	Programmable from 0.00 to 1.25 x VT in steps of 0.01
Pickup Level:	0.00 to 1.25 x VT in steps of 0.01
Dropout Level:	101 to 104% of pickup
Curve:	Definite Time, Inverse Time
Time Delay:	0.0 to 600.0 s in steps of 0.1
Operate Time:	Time delay ±30 ms @ 60Hz (V < 0.85 x PKP) Time delay ±40 ms @ 50Hz (V < 0.85 x PKP)
Time Delay Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater
Level Accuracy:	Per voltage input

PHASE/AUXILIARY/NEUTRAL/NEG SEQ OVERVOLTAGE (59P/59X/59N/59_2)

Minimum Voltage:	Programmable from 0.00 to 1.25 x VT in steps of 0.01
Pickup Level:	0.00 to 1.25 x VT in steps of 0.01
Dropout Level:	96 to 99% of pickup
Time Delay:	0.0 to 600.0 s in steps of 0.1
Operate Time:	Time delay ±35 ms @ 60Hz (V > 1.1 x PKP) Time delay ±40 ms @ 50Hz (V > 1.1 x PKP)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	Per voltage input

UNDERFREQUENCY (81U)

Minimum Voltage:	0.00 to 1.25 x VT in steps of 0.01
Pickup Level:	40.00 to 70.00 Hz in steps of 0.01
Dropout Level:	Pickup +0.03 Hz
Time Delay:	0.0 to 600.0 s in steps of 0.1
Time Delay Accuracy:	0 to 6 cycles (Time Delay selected)
Operate Time:	Typically 10 cycles @ 0.1Hz/s change
Level Accuracy:	±0.01 Hz

OVERFREQUENCY (81O)

Pickup Level:	40.00 to 70.00 Hz in steps of 0.01
Dropout Level:	Pickup -0.03 Hz
Time Delay:	0.0 to 600.0 s in steps of 0.1
Time Delay Accuracy:	0 to 6 cycles (Time Delay selected)
Operate Time:	Typically 10 cycles @ 0.1Hz/s change
Level Accuracy:	±0.01 Hz

TRANSIENT RECORDER

Buffer size:	3 s
No. of buffers:	1x192, 3x64, 6x32
No. of channels:	14
Sampling rate:	32 samples per cycle
Triggers:	Manual Command Contact Input Virtual Input Logic Element Element Pickup/Trip/Dropout/Alarm
Data:	AC input channels Contact input state Contact output state Virtual input state Logic element state
Data storage:	RAM - battery backed-up

METERING SPECIFICATIONS

Parameter	Accuracy	Resolution	Range
3-Phase Real Power (MW)	±1% of full scale	0.1 MW	±3000 MW
3-Phase Reactive Power (Mvar)	±1% of full scale	0.1 Mvar	±3000 Mvar
3-Phase Apparent Power (MVA)	±1% of full scale	0.1 MVA	3000 MVA
Power Factor	±0.05	0.01	-0.99 to 1.00
Frequency	±0.05 Hz	0.01 Hz	40.00 to 70.00 Hz

EVENT RECORDER

Number of events:	256
Header:	relay name, order code, firmware revision
Content:	event number, date of event, cause of event, per-phase current, ground current, sensitive ground current, neutral current, per-phase voltage (VTs connected in "Wye"), or phase-phase voltages (VTs connected in "Delta"), system frequency, power, power factor, thermal capacity
Data Storage:	Retained for 3 days

CLOCK

Setup:	Date and time Daylight Saving Time
IRIG-B:	Auto-detect (DC shift or Amplitude Modulated) Amplitude modulated: 1 to 10 V pk-pk DC shift: TTL Input impedance: 40kOhm ± 10% RTC Accuracy: ± 1 min / month

LOGIC ELEMENTS

Number of logic elements:	8
Trigger source inputs per element:	3
Block inputs per element:	3
Supported operations:	AND, OR, NOT, Pickup / Dropout timers
Pickup timer:	0 to 6000 ms in steps of 1 ms
Dropout timer:	0 to 6000 ms in steps of 1 ms

BREAKER CONTROL

Operation:	Asserted Contact Input, Logic Element, Virtual Input, Manual Command
Function:	Opens / closes the feeder breaker

AUTORECLOSE

Reclose attempts:	Up to 4 shots
Time Delay Accuracy:	0 to 3 cycles (AR Dead Time selected)
Elements:	Inputs, Outputs, Breaker Status (52 status)

BREAKER FAILURE

Pickup Level:	0.05 to 20.00 x CT in steps of 0.01
Dropout Level:	97 to 98% of pickup
Time Delay Accuracy:	0 to 1 cycle (Timer 1, Timer 2)
Level Accuracy:	per CT input

BREAKER TRIP COUNTER

Trip Counter Limit (Pickup):	1 to 10000 in steps of 1

COLD LOAD PICKUP BLOCKING

Operation:	Automatically (current level), or by command (asserted input)
Function:	Block IOC functions, raise TOC pickup, for selected period of time
Time Delay Accuracy:	0 to 1 cycle (block Time) ±50 ms (outage time? ≤?5 min) ±1 s (outage time > 5 min)

AMBIENT TEMPERATURE

High Temperature Pickup:	20°C to 80°C in steps of 1°C
Low Temperature Pickup:	-40°C to 20°C in steps of 1°C
Time Delay:	1 to 60 min in steps of 1 min ±50 ms (outage time? ≤?5 min) ±1 s (outage time > 5 min)
Temperature Dropout:	Configurable 90 to 98% of pickup
Temperature Accuracy:	±10°C
Timing Accuracy:	±1 second

CONTACT INPUTS

Inputs:	8
Selectable thresholds:	17, 33, 84, 166 VDC
Recognition time:	1/2 cycle
Debounce time:	1 to 64 ms, selectable, in steps of 1 ms
Continuous current draw:	2 mA
Type:	opto-isolated inputs
External switch:	wet contact
Maximum input voltage:	300 VDC

PHASE & GROUND CURRENT INPUTS

CT Primary:	1 to 6000 A
Range:	0.02 to 20 × CT
Input type:	1 A or 5 A (must be specified with order)
Nominal frequency:	50/60 Hz
Burden:	<0.1 VA at rated load
Accuracy:	±1% of reading at 1× CT ±3% of reading from 0.2 to 20 × CT ±20% of reading from 0.02 to 0.19 × CT
CT withstand:	1 second at 100 × rated current 2 seconds at 40 × rated current continuous at 3 × rated current

SENSITIVE GROUND CURRENT INPUT

CT Primary:	1 to 600 A
Range:	0.002 to 3 × CT
Input type:	1 A or 5 A (must be specified with order)
Nominal frequency:	50/60 Hz
Burden:	<0.1 VA at rated load
Accuracy:	±1% of reading at 0.1× CT ±3% of reading from 0.02 to 3 × CT ±20% of reading from 0.002 to 0.019 × CT
CT withstand:	1 second at 100 × rated current 2 seconds at 40 × rated current continuous at 3 × rated current

PHASE/AUX VOLTAGE INPUTS

Source VT:	0.12 to 65 kV / 50 to 220 V
VT secondary:	50 to 240 V
VT ratio:	1 to 5000 in steps of 1
Nominal frequency:	50/60 Hz
Accuracy:	±1.0% of reading
Voltage withstand:	260 VAC continuous

FORM-A RELAYS

Configuration:	2 (two) electromechanical
Contact material:	silver-alloy
Operate time:	<8 ms
Continuous current:	10 A
Make and carry for 0.2s:	30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms):	24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive):	24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive):	720 VA @ 250 VAC Pilot duty A300
Break (AC resistive):	277 VAC / 10 A

FORM-A VOLTAGE MONITOR

Applicable voltage:	20 to 250 VDC
Trickle current:	1 to 2.5 mA

FORM-C RELAYS

Configuration:	5 (five) electromechanical
Contact material:	silver-alloy
Operate time:	<8 ms
Continuous current:	10 A
Make and carry for 0.2s:	30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms):	24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive):	24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive):	720 VA @ 250 VAC Pilot duty A300
Break (AC resistive):	277 VAC / 10 A

TRIP / CLOSE SEAL-IN

Relay 1 trip seal-in:	0.00 to 9.99 s in steps of 0.01
Relay 2 close seal-in:	0.00 to 9.99 s in steps of 0.01

HIGH RANGE POWER SUPPLY

Nominal:	120 to 240 VAC 125 to 250 VDC
Range:	60 to 300 VAC (50 and 60 Hz) 84 to 250 VDC
Ride-through time:	35 ms

LOW RANGE POWER SUPPLY

Nominal:	24 to 48 VDC
Range:	20 to 60 VDC

ALL RANGES

Voltage withstand:	2 × highest nominal voltage for 10 ms
Power consumption:	15 W nominal, 20 W maximum 20 VA nominal, 28 VA maximum

SERIAL

RS485 port:	Opto-coupled
Baud rates:	up to 115 kbps
Response time:	1 ms typical
Parity:	None, Odd, Even
Maximum Distance:	1200 m (4000 feet)
Isolation:	2 kV
Protocol:	Modbus RTU, DNP 3.0, IEC 60870-5-103

ETHERNET (COPPER)

Modes:	10/100 MB (auto-detect)
Connector:	RJ-45
Protocol:	Modbus TCP/IP, DNP 3.0, IEC 60870-5-104, IEC 61850 GOOSE

ETHERNET (FIBER)

Fiber type:	100 MB Multi-mode
Wavelength:	1300 nm
Connector:	MTRJ
Transmit power:	-20 dBm
Receiver sensitivity:	-31 dBm
Power budget:	9 dB
Maximum input power:	-11.8 dBm
Typical distance:	2 km (1.25 miles)
Duplex:	half/full
Protocol:	Modbus TCP/IP, DNP 3.0, IEC 60870-5-104, IEC 61850 GOOSE

USB

Standard specification:	Compliant with USB 2.0
Data transfer rate:	115 kbps

CERTIFICATION

CE:	Low voltage directive EN60255-5 / EN60255-27 / EN61010-1 EMC Directive EN60255-26/ EN50263, EN61000-6-2, UL508
North America:	cULus UL1053, C22.2.No 14
ISO:	Manufactured under a registered quality program ISO9001

TYPE TESTS

Dielectric voltage withstand:		2.3KV
Impulse voltage withstand:	EN60255-5	5KV
Damped Oscillatory:	IEC 61000-4-18 IEC 60255-22-1	2.5KV CM, 1KV DM
Electrostatic Discharge:	EN61000-4-2/ IEC 60255-22-2	Level 4
RF immunity:	EN61000-4-3/ IEC 60255-22-3	Level 3
Fast Transient Disturbance:	EN61000-4-4/ IEC 60255-22-4	Class A and B
Surge Immunity:	EN61000-4-5/ IEC 60255-22-5	Level 3 & 4
Conducted RF Immunity:	EN61000-4-6/ IEC 60255-22-6	Level 3
Power Frequency Immunity:	EN61000-4-7/ IEC 60255-22-7	Class A & B
Voltage interruptionand Ripple DC:	IEC 60255-11	15% ripple, 200ms interupts
Radiated & Conducted: Emissions	CISPR11 /CISPR22/ IEC 60255-25	Class A
Sinusoidal Vibration:	IEC 60255-21-1	Class 1
Shock & Bump:	IEC 60255-21-2	Class 1
Siesmic:	IEC 60255-21-3	Class 2
Power magnetic Immunity:	IEC 61000-4-8	Level 5
Pulse Magnetic Immunity:	IEC 61000-4-9	Level 4
Damped Magnetic Immunity:	IEC 61000-4-10	Level 4
Voltage Dip & interruption:	IEC 61000-4-11	0, 40, 70, 80% dips, 250/ 300 cycle interrupts
Damped Oscillatory:	IEC 61000-4-12	2.5KV CM, 1KV DM
Conducted RF Immunity 0-150khz:	IEC 61000-4-16	Level 4
Voltage Ripple:	IEC 61000-4-17	15% ripple
Ingress Protection:	IEC 60529	IP40 front , IP10 Back
Environmental (Cold):	IEC 60068-2-1	-40C 16 hrs
Environmental (Dry heat):	IEC 60068-2-2	85C 16hrs
Relative Humidity Cyclic:	IEC 60068-2-30	6day variant 2
EFT:	IEEE/ANSI C37.90.1	4KV, 2.5Khz
Damped Oscillatrory:	IEEE/ANSI C37.90.1	2.5KV,1Mhz
RF Immunity:	IEEE/ANSIC37.90.2	20V/m 80-1Ghz
ESD:	IEEE/ANSIC37.90.3 UL508	8KV CD/ 15KV AD e83849 NKCR
Safety:	UL C22.2-14 UL1053	e83849 NKCR7 e83849 NKCR

DIMENSIONS

Size:	Refer to Dimensions Chapter
Weight:	4.1 kg [9.0 lb]

OPERATING ENVIRONMENT

Ambient operating temperature:	–40°C to +60°C [-40°F to +140°F]
Ambient storage / shipping temperature:	–40°C to +85°C [-40°F to +185°F]
Humidity:	Operating up to 95% (non condensing) @ 55C (As per IEC 60068-2-30 Variant 2, 6days)
Pollution degree:	II
Overvoltage category:	III
Ingress Protection:	IP40 Front , IP10 back

Ordering

	350	E	**	**	*	*	*	*	*	**	D	*	Description
Base Unit	350												
Language		E											English
Phase Currents			P1										1A three phase current inputs
			P5										5A three phase current inputs
Ground Currents				G1									1A ground current input
				G5									5A ground current input
				S1									1A sensitive ground current input
				S5									5A sensitive ground current input
Power Supply					L								24 - 48 Vdc
					H								125 - 250 Vdc/120 - 240Vac
Faceplate						S							Standard faceplate (LCD, full menu, actual values and setpoints) with 8 Inputs, 7 Outputs (2 Form A, 5 Form C) --- Only for 350
						E							Standard faceplate (LCD, full menu, actual values and setpoints) with 10 Inputs, 7 Outputs (2 Form A, 5 Form C)
Current Protection							S						Standard Overcurrent Protection - 50P(1), 50G(1), 50N(1), 51P(1), 51G(1), 51N(1)
							E						Extended Overcurrent Protection - 49, 50P(2), 50G(2), 50N(2), 51P(1), 51G(1), 51N(1)
							M						Advanced overcurrent protection - 49, 50P(2), 50G(2), 50N(2), 51P(1), 51G(1), 51N(1), 50_2 (46)
Control								N					No Selection
								C					CLP, 50BF, Autoreclose (79), Lockout (86)
Options									N				No Selection
									D				Directional Neutral Overcurrent Protection 67N(1), 67G(1)
									M				Voltage Metering
									R				Neutral and Ground Directional elements 67N(1), 67G(1) + Voltage Metering
									P				Voltage Protection, Neutral and Ground Directional elements - 27P(1), 27X(1), 59P(1), 59N(1), 59X(1), 59_2(1), 81O(2), 81U(2), 67N(1), 67G(1)
Communications										SN			Standard :Front USB, Rear RS485 : Modbus RTU, DNP3.0, IEC 60870-5-103
										1E			Standard + Ethernet (Copper & Fiber - MTRJ) MODBUS TCP/IP, DNP3.0, IEC 60870-5-104
										2E			Standard + Ethernet (Copper & Fiber - MTRJ) MODBUS TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850 GOOSE
										3E			Standard + Ethernet (Copper & Fiber - MTRJ) MODBUS TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850
Case Design											D		Draw-out Design
Harsh Environment												N	None
												H	Harsh Environment Conformal coating

Note: 1) G1/G5 and S1/S5 must match corresponding P1/P5 - there cannot be 5A and 1A mixing

Accessories for the 350

- Multilink Ethernet Switch — ML2400-F-HI-HI-A2-A2-A6-G1
- Viewpoint Maintenance — VPM-1
- Viewpoint Monitoring IEC 61850 — VP-1-61850

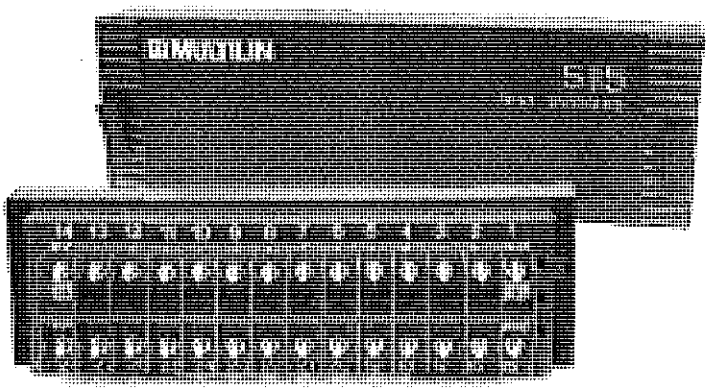
Visit www.GEMultilin.com/350 to:

- Download the instruction manual
- Review applications notes and support documents
- Buy a 350 online
- View the 350 brochure

515

MULTILIN

BLOCKING AND TEST MODULE



FEATURES

- 14 Pole switchbank
- CT inputs short when current switches are open.
- Current injection for each phase
- Ability to visually isolate (open) trip relay output circuits.
- Cover provided
- Suitable for utility and industrial use.
- 515 test plugs available.

DESCRIPTION

The 515 Blocking and Test Module provides an effective means of trip blocking, relay isolation and testing of Multilin relays. By opening the switches and inserting test plugs, phase and residual currents from the primary CTs can be monitored. Currents can be injected into the relay from a secondary injection test set during commissioning.

Prior to withdrawal, the trip and auxiliary circuits must be opened first, to prevent nuisance tripping, and CT's can then be shorted. Conversely, when the test is done and the relay is put back in operation, the CT switches should be closed first to ensure normal operation of the relay, prior to closing the trip and auxiliary circuits.

TYPICAL WIRING

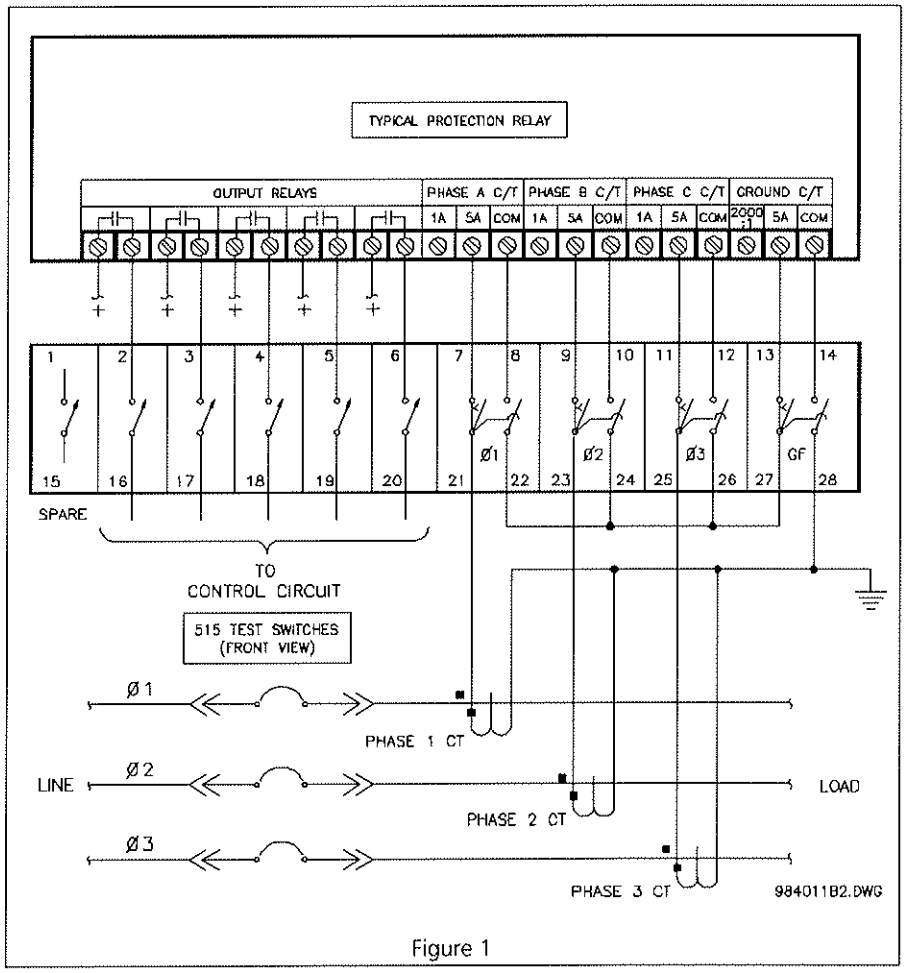


Figure 1

1601-0024-A4, 04/18/96

215 ANDERSON AVE., MARKHAM, ONT. L6E 1B3 FACTORY TEL: (905) 294-6222 FAX: (905) 294-8512

515

GE MULTILIN

MOUNTING & INSTALLATION

The 515 Blocking and Test Module consists of a metal chassis attached to the 515 test switches that slides into the panel. A single cutout in the panel, as per the dimensions shown in Figure 4, is required to mount the 515 test switches.

Slide the metal chassis attached to the 515 test switches into the cutout from the front of the panel. While firmly applying pressure from the front of the 515 module to ensure the chassis fits snugly, bend out the retaining tabs as shown in Figure 3. Usually the retaining tabs will be sufficient to hold the 515 module securely in place. If additional fastening is desired bend out the clamping screw tabs at both ends of the chassis at right angles. Insert the #8 screws provided in the accessory pouch into the tapped holes with the vibration proof nut between the tab and the panel. Tighten each screw until the end of the screw butts firmly against the front panel. Ensure the nut is installed tightly against the bent tab. Nylon inserts in these nuts prevent them from vibrating loose. The 515 test switch module should now be securely mounted to the panel with no movement ready for rear terminal wiring. When completed, place the front cover over the mounted 515 test module and push the fasteners at both ends down into place, as shown in Figure 2.

DETAILED OPERATION

To put the 515 Blocking & Test Module into operation, additional parts have been provided:

- 1 package containing at least 28 terminal nuts
- 14 white tags for identification of each of the switches

The 515 provides a means of trip blocking, relay isolation, and testing of Multilin relays. The 515 accomplishes this with a total of 14 switches. There are 6 single pole throw switches for use with the output relays, and 4 groups of 2 switches each for use with the current transformers as illustrated in Figure 1.

PHYSICAL DIMENSIONS

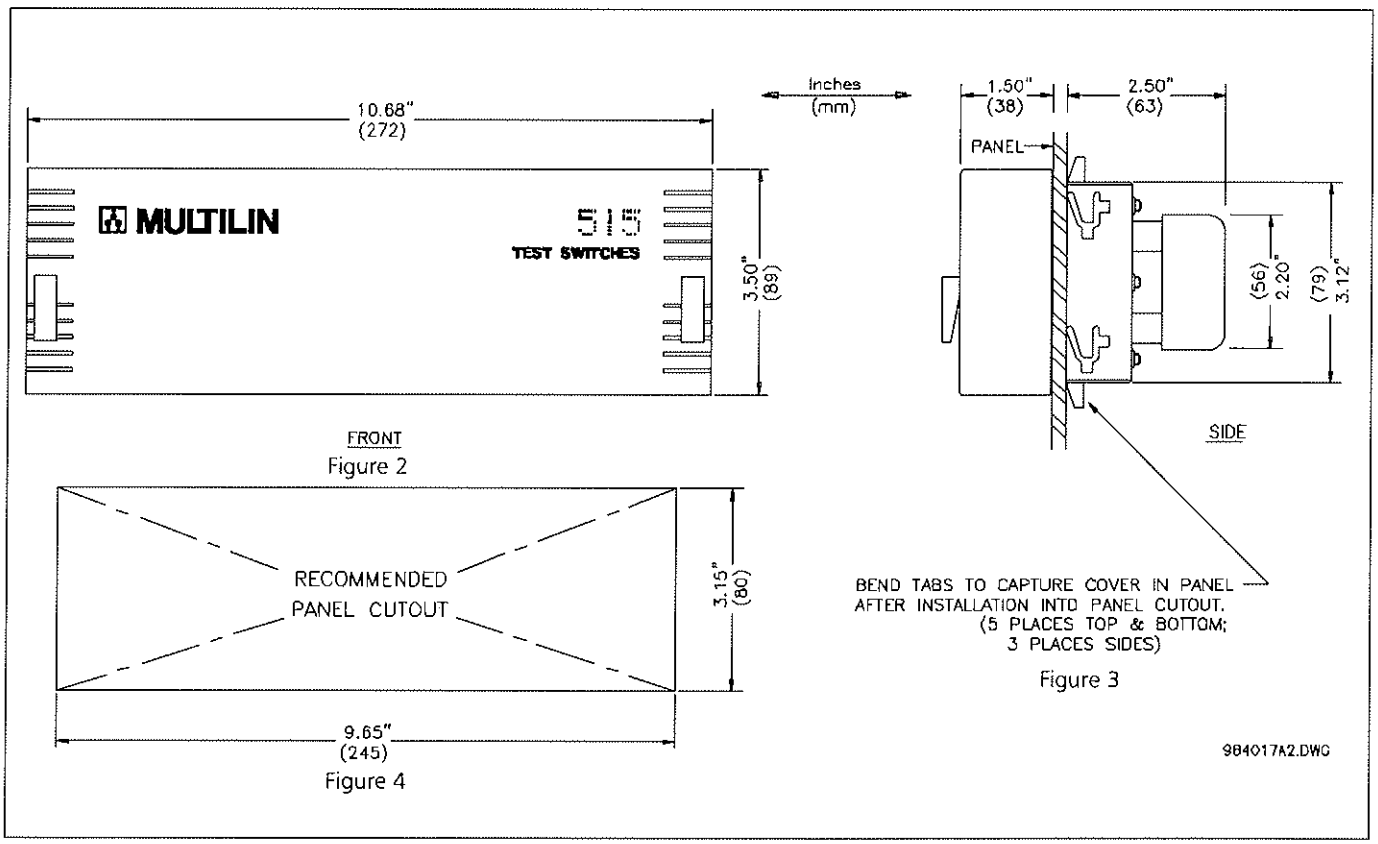


Figure 2

Figure 3

Figure 4

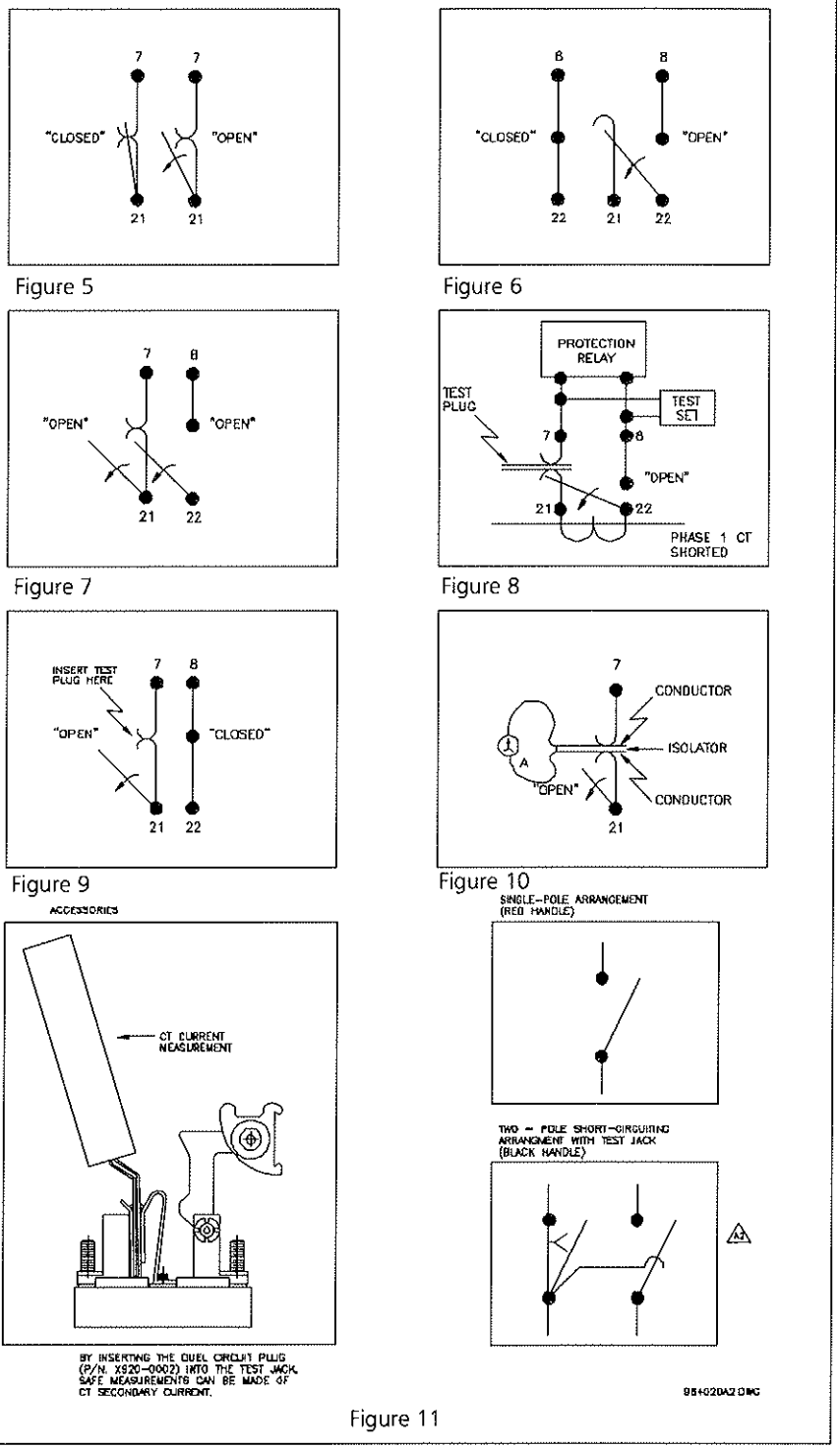
215 ANDERSON AVE., MARKHAM, ONT. L6E 1B3 FACTORY TEL: (905) 294-6222 FAX: (905) 294-8512

DETAILED OPERATION

Isolation or opening of the relay's output circuits is accomplished with the six switches at terminals 1 through 6 and 15 through 20. These switches can be used to simply open the protection relay's output contacts and thus provide a means of blocking trips. The 4 remaining groups of 2 switches at terminals 7 through 14 and 21 through 28 are used for shorting of the CT inputs, injection of test current, and measuring of CT current. The 4 groups correspond to Phase 1 Current, Phase 2 Current, Phase 3 Current, and Ground Current.

Each group is made up of two switches.. The first switch for the Phase 1 group is at terminal 7 and 21 and is configured as in Figure 5. Note that terminals 7 and 21 are shorted together regardless of whether the switch is open or closed. The second switch for the Phase 1 group is at terminals 8 and 22. It is configured as in Figures 6 & 7. Note that this switch operates as make before break. When this switch is closed terminals 8 and 22 are shorted together. When this switch is open, terminals 8 and 22 open and 22 shorts with 7 and 21. This in turn shorts Phase 1 CT. It is essential that the CT is connected to the shorted side of the switch as shown in Figure 8. Otherwise, dangerously high voltages would be present at the open circuited current transformer. Also note that currents can be injected into the protection relay from a secondary injection test set. See Figure 8.

With the switch between terminals 7 and 21 open and the switch between terminals 8 and 22 closed as shown in Figure 9, a 515 test plug can be inserted between terminals 7 and 21 to monitor the CT current. See Figure 10. Note that the 515 test plug is made up of two conductors separated by an insulator as shown in Figures 10 & 11.



30.5 mm Push Buttons

Product Overview

Bulletin 800T/800H 30.5 mm Push Buttons

- 30.5 mm mounting hole
- Type 4/13 watertight/oiltight (Bul. 800T)
- Type 4/4X/13 corrosion-resistant/watertight/oiltight (Bul. 800H)
- Heavy industrial stations and operators

Table of Contents

See below.

Standards Compliance

UL 508

CCC

Certifications

UL Listed
(File No. E14840, E10314
Guide No. NKCR, NOIV)

CSA Certified
(File No. LR1234, LR11924)

CSA C22.2, No. 14

EN/IEC: 60947-5-1

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Specifications*

Electrical Ratings		
Contact ratings		Refer to the contact ratings tables on page 10-4.
Dielectric strength		2200V for one minute, 1300V for one minute (Logic Reed)
Electrical design life cycles		1 000 000 at max. rated load, 200 000 at max. rated load (Logic Reed)
Mechanical Ratings		
Vibration		10…2000 Hz, 1.52 mm displacement (peak-to-peak) max./ 10 G max. (except Logic Reed)
Shock		1/2 cycle sine wave for 11 ms ≥ 25 G (contact fragility) and no damage at 100 G
Degree of protection		Type 1/4/12/13 (800T); Type 1/4/4X/12/13 (800H); EN/IEC 60529 IP66/65
Mechanical design life cycles		
Push buttons	(Momentary, non-illuminated)	10 000 000 min.
	(Momentary, illuminated)	250 000 min.
	(Push-pull/twist-to-release)	250 000 min.
Selector switches	(Non-illuminated)	1 000 000 min.
	(Illuminated, key-operated)	200 000 min.
Potentiometers		25 000 min.
All other devices		200 000 min.
Contact operation		Shallow, mini, and low-voltage contact blocks: Slow, double make and break Logic Reed and sealed switch contact blocks: Single break magnetic
Wire gauge/Terminal screw torque		#18…14 AWG (#18…10 Max Duty) / 6…8 lb•in.
Typical operating forces Operators without contact blocks		Flush, extended button, standard mushroom, jumbo plastic mushroom: 2 lbs max. Jumbo and extended aluminum mushroom head: 3.95 lbs max. Maintained selector switch: 3.6 in•lb max.
Spring return selector switches		3.6 in•lb to stop, 0.2 in•lb to return
Illuminated push buttons and push-to-test pilot lights		5 lb max.
2-position push-pull		7.5 lb max. push or pull
3-position push-pull		8 lb max. push to in position or pull to center position (15 lb max. pull to out position)
Twist-to-release or push-pull		9 lbs max. push or pull 30 in•oz max. twist, 6 in•oz minimum return
Potentiometer		Rotational torque 3…12 in•oz; stopping torque 12 in•lb (minimum)
Contact blocks	Standard	1 lb
	Logic Reed	1 lb max.
	Sealed switch	3 lb max. at 0.205 in. plunger travel
	Stackable sealed switch	1 lb max.
Environment		
Temperature range	Operating	–40…+131 °F (–40…+55 °C)
	Storage	–40…+185 °F (–40…+85 °C)
Note: Operating temperatures below freezing are based on the absence of moisture and liquids. Consult your local Rockwell Automation sales office or Allen-Bradley distributor for use in lower temperature applications.		
Humidity		50…95% RH from 77…140 °F (25…60 °C) per Procedure IV of MIL-STD-BIOC, Method 507.1 cycling test

* Performance Data — See Important-3.

Standard Contact Ratings

Minimum: 24V, 24 mA

Maximum thermal continuous current I_{th} 10 A AC/2.5 A DC. Bulletin 800T units with 800T-XA contacts have ratings as follows:

Max. Opertnl. Volts U_e	Utilization Category		Rated Operational Currents		
	IEC	NEMA	Volts U_e	Make	Break
AC 600	AC-15	A600	120…600 72…120 24…72	7200VA 60 A 60 A	720VA 720VA 10 A
DC 600	DC-13	Q600	28…600 24…28∗	69VA 2.5 A	

∗ For applications below 24V/24 mA, Pen*TUFF*™ or Logic Reed contacts are recommended.

Sealed Switch Contact Ratings

Minimum: 5V, 1 mA

Maximum continuous current I_{th} 5 A. Bulletin 800T units have control circuit ratings with sealed switch contact blocks as follows:

Max. Opertnl. Volts U_e	Utilization Category		Rated Operational Currents		
	IEC	NEMA	Volts U_e	Make	Break
AC 600	AC-15	B600	120…600 0…120	3600VA 30 A	360VA 3 A
DC 300	DC-13	P300	24…300 0…24	138VA 5.0 A	

Stackable Sealed Switch Contact Ratings

Minimum: 5V, 10 mA (digital); 24V, 1 mA (analog)

Maximum continuous current I_{th} 2.5 A. Bulletin 800T untis have control circuit ratings with sealed switch contact blocks as follows:

Max. Opertnl. Volts U_e	Utilization Category		Rated Operational Currents		
	IEC	NEMA	Volts U_e	Make	Break
AC 300	AC-15	C300	120…300 0…120	1800VA 15 A	180VA 1.5 A
DC 150	DC-13	Q150	24…150 0…24	69VA 2.5 A	

Logic Reed Contact Ratings

Minimum — DC: 5V, 1 mA
Maximum — DC: 30V, 0.06 A, AC: 150V, 0.15 A
Should only be used with resistive loads.

Materials Used in 800H Type 4X Operators

Thermoplastic Polyester (Fiberglass Reinforced)

- Bushings
- Mounting Rings
- Sockets

Thermoplastic Polyester

- Non-illuminated button caps

Transparent Amorphous Nylon

- Pilot light lens cap
- Illuminated button caps

Glass Filled Crystalline Nylon

- Thrust washer

Mineral Filled Nylon

- Trim washer

Nitrile (Synthetic Rubber)

- Gaskets and internal seals

Pen*TUFF*™ (Low Voltage) Contact Ratings

Minimum DC: 5V, 1 mA
Maximum thermal continuous current I_{th} 2.5 A AC/1.0 A DC. Bulletin 800T units with 800T-XAV contacts have ratings as follows:

Max. Opertnl. Volts U_e	Utilization Category		Rated Operational Currents		
	IEC	NEMA	Volts U_e	Make	Break
AC 300	AC-15	C300	120…300 0…120	1800VA 15 A	180VA 1.5 A
DC 150	DC-13	R150	24…150 0…24	28VA 1.0 A	

Snap Action Contact Ratings

Max. Opertnl. Volts U_e	Contact Rating Designation	Rated Operational Currents		
		Volts U_e	Make	Break
AC 300	A300	120…300 24…72	7200VA 60 A	720VA 10 A
DC 250	—	230…250 115…125	0.2 A 0.4 A	

MaxDuty Contact Rating

Maximum thermal continuous current I_{th} 24 A.
Pilot Duty — 120V AC, 12 A; 24V DC, 10 A
Motor Ratings — 120V AC, 1.5 Hp; 240V AC, 3 Hp; 24V DC, 10 A FLA/60 A LRA

Time Delay Contacts

Max. Opertnl. Volts U_e	Contact Rating Designation	Rated Operational Currents		
		Volts U_e	Make	Break
AC 120	B150	120	3600VA	360VA

Note: This device is not rated for DC applications.

Adjustment range: 0.5…15 s ± 25% I_{th} = 5 A

Momentary Contact Push Button Units, Non-Illuminated

Flush Head Unit
Cat. No. 800T-A1A

Extended Head Unit
Cat. No. 800T-B6A

Booted Unit
Cat. No. 800H-R2A

Bootless Flush Head Unit
Cat. No. 800H-AR1A

Contact Type	Button Color	Type 4/13		Type 4/4X/13	
		Flush Head	Extended Head	Booted∗	Bootless Flush Head
		Cat. No.	Cat. No.	Cat. No.	Cat. No.
No Contact	Green	**800T-A1**	**800T-B1**	**800H-R1**	**800H-AR1**
	Black	**800T-A2**	**800T-B2**	**800H-R2**	**800H-AR2**
	Red	**800T-A6**	**800T-B6**	**800H-R6**	**800H-AR6**
1 N.O.	Green	**800T-A1D1**	**800T-B1D1**	**800H-R1D1**	**800H-AR1D1**
	Black	**800T-A2D1**	**800T-B2D1**	**800H-R2D1**	**800H-AR2D1**
	Red	**800T-A6D1**	**800T-B6D1**	800H-R6D1	**800H-AR6D1**
1 N.C.	Green	**800T-A1D2**	**800T-B1D2**	800H-R1D2	800H-AR1D2
	Black	**800T-A2D2**	**800T-B2D2**	800H-R2D2	**800H-AR2D2**
	Red	**800T-A6D2**	**800T-B6D2**	**800H-R6D2**	**800H-AR6D2**
1 N.O. - 1 N.C.	Green	**800T-A1A**	**800T-B1A**	**800H-R1A**	**800H-AR1A**
	Black	**800T-A2A**	**800T-B2A**	**800H-R2A**	**800H-AR2A**
	Red	**800T-A6A**	**800T-B6A**	**800H-R6A**	**800H-AR6A**

800 T [ ] – A 1 [ ] A
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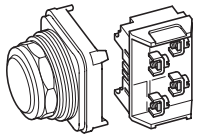

a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Operator Type		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
A	Flush Head	AR
B	Extended Head	BR
D	Mushroom Head	DR
DX	Mushroom Head less Color Cap	DRX
—	Bootless Guarded Head	GR
—	Booted Head	R∗

d

Color Cap	
Code	Description
Blank	Used only when ordering Operator Type DX/DRX
1	Green
2	Black
3	Orange❄

d (cont'd)

Color Cap	
Code	Description
4	Gray❄
5	White❄
6	Red
7	Blue
9	Yellow

e

Special Mushroom Head	
Code	Description
J§	Jumbo Mushroom Head — Plastic
L§	Jumbo Mushroom Head — Metal
Note: Special Mushroom Head options only apply to Mushroom Head operator Type Code D/DR.	

f

Contact Block(s)	
Code	Description
Blank	No Contacts
Standard	
D1	1 N.O.
D2	1 N.C.
D3	1 N.O.E.M.
D4	1 N.C.L.B.
D5	1 N.O. (Mini)
D6	1 N.C. (Mini)
A1	1 N.C.L.B. - 1 N.O.
A2	2 N.O.‡
A4	2 N.C.
A7	1 N.C.L.B. - 1 N.C.
A	1 N.O. - 1 N.C.
B	2 N.O. - 2 N.C.

f (cont'd)

Contact Block(s)	
Code	Description
Pen*TUFF* (Low Voltage)	
D1V	1 N.O.
D2V	1 N.C.
D3V	1 N.O.E.M.
D4V	1 N.C.L.B.
AV	1 N.O. - 1 N.C.
BV	2 N.O. - 2 N.C.
Time Delay	
T	1 N.O. Depress close, delayed opening
S	1 N.C. Depress open, delayed closure
Snap Action	
M	1 N.O. - 1 N.C.
N	2 N.O. - 2 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
D1R	1 N.O.
D2R	1 N.C.
A2R	2 N.O.‡
A4R	2 N.C.
AR	1 N.O. - 1 N.C.
BR	2 N.O. - 2 N.C.

f (cont'd)

Contact Block(s)	
Code	Description
Class 1, Div. 2/Zone 2	
Sealed Switch	
D1P	1 N.O.
D2P	1 N.C.
A2P	2 N.O.
A4P	2 N.C.
AP	1 N.O. - 1 N.C.
BP	2 N.O. - 2 N.C
Stackable Sealed Switch	
D1Y	1 N.O.
D2Y	1 N.C.
A2Y	2 N.O.
A4Y	2 N.C.
AY	1 N.O. - 1 N.C.
BY	2 N.O. - 2 N.C

Time Delay Contacts

Series C field installable kits can only be used with Series T or later operators. Adjustable range of 0.5 to 15 s + 25%. Maximum continuous current Ith 5 A.

Snap Action Contacts

Snap action contacts feature a quick make, quick break snap-action mechanism that is only available on factory assembled units. Maximum continuous current I_{th} 10 A.

∗ Underlying operators are "flush head" type, except red which are "extended head". Boot material is hyplon with brass threaded insert.
❄ Not available for booted operators.
‡ A2 and A2R contact blocks cannot be stacked upon, but can stack on other contact blocks.
§ Jumbo mushroom heads not available in white color.

30.5 mm Push Buttons

Selector Switches, Continued

3-Position Selector Switch Units, Non-Illuminated

Standard Knob Operator
Cat. No. 800T-J2A

Knob Lever Operator
Cat. No. 800T-J17A

Standard Knob Operator
Cat. No. 800H-JR2A

Contact Type	Operator Position			M = Maintained S = Spring Return	Type 4/13 Standard Knob Cat. No.	Type 4/13 Knob Lever Cat. No.	Type 4/4X/13 Standard Knob Cat. No.
No Contacts	—	—	—	M M M	**800T-J2**	**800T-J17**	**800H-JR2**
				S→M M	**800T-J4**	800T-J18	**800H-JR4**
				M M←S	**800T-J5**	800T-J19	800H-JR5
				S→M←S	**800T-J91**	**800T-J20**	**800H-JR91**
1 N.O. - 1 N.C.	O X	O O	X O	M M M	**800T-J2A**	**800T-J17A**	**800H-JR2A**
				S→M M	**800T-J4A**	**800T-J18A**	**800H-JR4A**
				M M←S	**800T-J5A**	**800T-J19A**	**800H-JR5A**
				S→M←S	**800T-J91A**	**800T-J20A**	**800H-JR91A**

Note: X = Closed/O = Open

800 T [ ] – J 2 [ ] C

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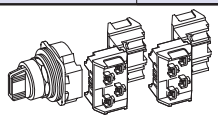


a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Knob Insert Colors		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
J	White	JR
JA	Red	JRA
JB	Green	JRB
JC	Blue	JRC
JE	Yellow	JRE
JF	Orange	JRF
JX	Packet of Colored Inserts✶	JRX
Metal Wing Lever Colors❄		
Code	Color	Code
JA	Red	—
JG	Gray	—

d

Knob/Lever Type Operators	
Standard Knob	
Code	Operator Function
2	Maintained
4	Spring Return from Left
5	Spring Return from Right
91	Spring Return from Both
Knob Lever❄	
Code	Operator Function
17	Maintained
18	Spring Return from Left
19	Spring Return from Right
20	Spring Return from Both
Metal Wing Lever❄	
Code	Operator Function
11	Maintained
15	Spring Return from Left
16	Spring Return from Right
141	Spring Return from Both
Coin Slot❄	
Code	Operator Function
10	Spring Return from Both

e

Cam Option‡♣	
Code	Description
Blank	KB7 Cam (Std.)
KA1	KA1 Cam
KA7	KA7 Cam

e (cont'd)

Cam Option‡♣	
Code	Description
KC1	KC1 Cam
KC7	KC7 Cam
KD7	KD7 Cam
KE7§	KE7 Cam
KQ1	KQ1 Cam
KQ7	KQ7 Cam
KR1§	KR1 Cam
KR7§	KR7 Cam
KT1§	KT1 Cam
KT7§	KT7 Cam
KU7§	KU7 Cam

f

Contact Blocks	
Code	Description
Blank	No Contacts on operator
Standard	
A	1 N.O. - 1 N.C. 1-**800T-XA** on white side
B	2 N.O. - 2 N.C. 2-**800T-XA**s — 1 on white side/1 on black side
PenTUFF (Low Voltage)	
AV	1 N.O. - 1 N.C. 1-**800T-XAV** on white side
BV	2 N.O. - 2 N.C. 2-**800T-XAV**s — 1 on white side/1 on black side

f (cont'd)

Contact Blocks♣	
Code	Description
Blank	No Contacts
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C. 1-**800T-XAR** on white side
BR	2 N.O. - 2 N.C. 2-**800T-XAR**s — 1 on white side/1 on black side
Sealed Switch	
AP	1 N.O. - 1 N.C. 1-**800T-XAP** on white side
BP	2 N.O. - 2 N.C. 2-**800T-XAP**s — 1 on white side/1 on black side
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C. 1-**800T-XAY** on white side
BY	2 N.O. - 2 N.C. 2-**800T-XAY**s — 1 on white side/1 on black side

✶ One insert of each color.
❄ Only available on 800T, Type 4/13 operators.
‡ If an overlapping cam is required, consult your local distributor.
§ Not available with wing levers.
♣ See Table 1 for cam selections and associated targets.

Table 1. Cam and Contact Block Functionality Table

| Contact Block Suffix Code | Contact Block Side | Circuits | Cam Codes | | | |

30.5 mm Push Buttons

Pilot Lights

Pilot Light Units✶

Transformer Type Pilot Light
Cat. No. 800T-P16R

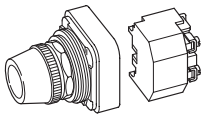
Push-to-Test Pilot Light
Cat. No. 800T-PT16R

Type	Lamp Type	Volts	Color	Type 4/13 Pilot Light Cat. No.	Type 4/13 Push-to-Test✶ Cat. No.	Type 4/4X/13 Pilot Light Cat. No.	Type 4/4X/13 Push-to-Test✶ Cat. No.
Operator Only❄				800T-S00	800T-SB00XX	**800H-SR00**	800H-SRB00XX
Full Voltage‡	Incandescent	24V AC/DC	Red	**800T-Q24R**	**800T-QT24R**	**800H-QR24R**	800H-QRT24R
			Green	**800T-Q24G**	**800T-QT24G**	**800H-QR24G**	800H-QRT24G
			Amber	**800T-Q24A**	**800T-QT24A**	**800H-QR24A**	800H-QRT24A
	LED	120V AC only	Red	**800T-QH10R**	**800T-QTH10R**	**800H-QRH10R**	800H-QRTH10R
			Green	**800T-QH10G**	**800T-QTH10G**	**800H-QRH10G**	800H-QRTH10G
			Amber	**800T-QH10A**	800T-QTH10A	**800H-QRH10A**	800H-QRTH10A
		24V AC/DC	Red	**800T-QH24R**	**800T-QTH24R**	**800H-QRH24R**	800H-QRTH24R
			Green	**800T-QH24G**	800T-QTH24G	**800H-QRH24G**	800H-QRTH24G
			Amber	**800T-QH24A**	800T-QTH24A	**800H-QRH24A**	800H-QRTH24A
	No Lamp	0…250V AC/DC	No Lens	800T-QN25	800T-QTN25	—	—
Transformer‡	Incandescent	120V AC, 50/60 Hz	Red	**800T-P16R**	**800T-PT16R**	**800H-PR16R**	**800H-PRT16R**
			Green	**800T-P16G**	**800T-PT16G**	**800H-PR16G**	**800H-PRT16G**
			Amber	**800T-P16A**	**800T-PT16A**	**800H-PR16A**	**800H-PRT16A**
	LED		Red	**800T-PH16R**	**800T-PTH16R**	**800H-PRH16R**	800H-PRTH16R
			Green	**800T-PH16G**	**800T-PTH16G**	**800H-PRH16G**	800H-PRTH16G
			Amber	**800T-PH16A**	**800T-PTH16A**	**800H-PRH16A**	800H-PRTH16A
	No Lamp		No Lens	800T-PN16	800T-PTN16	—	—

✶ Includes one standard Cat. No. 800T-XA (1 N.O. - 1 N.C.) contact block. For typical pilot light wiring diagrams, see page 10-63.
❄ Operator only supplied without power module, lamp, lens cap, or contact blocks.
‡ All pilot lights except push-to-test without sealed contacts and dual input transformer relay, are rated for Class 1, Division 2 applications.

(Push-to-Test)

800	T		–	Q	T		24	G	AR
	a	*b*		*c*	*d*	*e*	*f*	*g*	*h*



a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Power Module Type		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
P	Transformer (or Dual Input)	PR
Q	Full Voltage (or Resistor)	QR
R	Neon§	RR

d

Lamp Test Options	
Code	Description
Blank	No Test Option
T	Push-to-Test
D	Dual Input — Diode♣
DT	Dual Input — Transformer Relay
Note: Push-to-Test supplied with factory jumpered Contact Block.	

e

Illumination Options	
Transformer/Full Voltage	
Code	Description
Blank	Incandescent
F	Flashing Incandescent➢
H	LED⌘
Resistor/Neon	
Blank	No Options
Dual Input	
Blank	Incandescent
H	LED⌘

f

Voltage	
Transformer	
Code	Description
36	48V AC 50/60 Hz
16	120V AC 50/60 Hz
26	240V AC 50/60 Hz
76	277V AC 50/60 Hz
46	480V AC 50/60 Hz
56	600V AC 50/60 Hz
Full Voltage	
06	6V AC/DC
12	12V AC/DC
24	24V AC/DC
32	32V AC/DC✦
48	48V AC/DC
10	120V AC/DC❖
13	130V AC/DC✦
20	240V AC/DC✦
Resistor	
11	120V AC/DC Resistor
Neon	
10	120V AC/DC
20	240V AC/DC
Dual Input	
16	120V AC
24	24V AC/DC (Dual input diode only)

g

Lens Color		
Code	Color	Glass Code♠
Blank	No Lens	Blank
A	Amber	D
B	Blue	E
C	Clear	F
G	Green	H
R	Red	J
W	White	K

h

Contact Blocks (Push-to-test units only)	
Code	Description
Standard	
Blank	1 N.O. - 1 N.C.
Pen*TUFF* (Low Voltage)	
AV	1 N.O. - 1 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C.
Sealed Switch	
AP	1 N.O. - 1 N.C.
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C.

§ Neon is only available in amber or clear.
♣ Diode type dual input provides circuit isolation via opposing diodes. Not recommended for use with solid-state outputs and neon indicators.
➢ Flashing lamps are only available in 6V and all transformer units.
⌘ LEDs available in red, green, amber, blue, and white. White LEDs only available in 6V, 24V, 120V, and 130V full voltage and all transformer units. LED color matches lens color, except clear lens supplied with white LED and white lens supplied with amber LED. All LEDs except 120V have an internal shunt resistor for use with solid-state outputs.

✦ 32V and 130V are LED only. 240V is incandescent only.
❖ 120V LED is AC only and does not contain internal shunt resistor. For AC/DC and internal shunt resistor, order 130V AC/DC LED (Code 13).
♠ Glass lens available on 800T pilot lights only. Not available on push-to-test units.

2-Position Push-Pull and Push-Pull/Twist Release Units, Non-Illuminated

Note: A jumbo or large legend plate is recommended, if space allows.

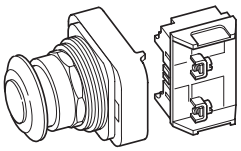
2-Position Push-Pull
Cat. No. 800T-FX6D4

2-Position Push-Pull/Twist
Cat. No. 800T-FXT6D4

2-Position Push-Pull/Twist
Cat. No. 800H-FRXT6D4

Contact Type	Operator Position: Maintained Out	Operator Position: Maintained In	Button Color	Type 4/13: Push-Pull‡ Cat. No.	Type 4/13: Push-Pull/Twist Release‡ Cat. No.	Type 4/4X/13: Push-Pull/Twist Release‡ Cat. No.
N.C.L.B.	X	O	Red	**800T-FX6D4**	**800T-FXT6D4**	**800H-FRXT6D4**
N.O. - N.C.L.B.✶	O X	X O		**800T-FX6A1**	**800T-FXT6A1**	**800H-FRXT6A1**
N.C.L.B. - N.C.L.B.✶	X X	O O		**800T-FX6A5**	**800T-FXT6A5**	**800H-FRXT6A5**

Note: X = Closed/O = Open



800 T – FX 1 A1
a b c d e

a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Head Type‡		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
FX	Mushroom Head (Push-Pull)	—
FXC	90 mm Anodized Aluminum Head (Push-Pull)	—
FXJ	Jumbo Mushroom Head (Push-Pull)	—
FXJE	Jumbo Mushroom Head (Push-Pull) with "E-Stop"	—
FXL	63 mm Anodized Aluminum Head (Push-Pull)	—
FXLE	63 mm Anodized Aluminum Head (Push-Pull) with "E-Stop"	—
FXT	Push-Pull/Twist to Release	FRXT
FXJT	Jumbo Head Push-Pull w/Twist to Release	FRXJT

d

Color Cap	
Code	Color
Blank	No Cap§
1	Green
2	Black
3	Orange
4	Gray
5	White
6	Red
7	Blue
9	Yellow

e

Contact Block(s)			
Code	Operator Position: Out	Operator Position: In	Description
Blank	—	—	No Contacts on operator
Standard			
D1	O	X	1 N.O.
D2	X	O	1 N.C.
D4	X	O	1 N.C.L.B.
A	O X	X O	1 N.O. - 1 N.C.
A1	O X	X O	1 N.O. - 1 N.C.L.B.
A5	X X	O O	2 N.C.L.B.

e (cont'd)

Contact Block(s)			
Code	Operator Position: Out	Operator Position: In	Description
Blank	—	—	No Contacts
Pen*TUFF* (Low Voltage)			
D1V	O	X	1 N.O.
D2V	X	O	1 N.C.
D4V	X	O	1 N.C.L.B.
AV	O X	X O	1 N.O. - 1 N.C.
Class 1, Div. 2/Zone 2			
Logic Reed			
D1R	O	X	1 N.O.
D2R	X	O	1 N.C.
AR	O X	X O	1 N.O. - 1 N.C.
Sealed Switch			
D1P	O	X	1 N.O.
D2P	X	O	1 N.C.
AP	O X	X O	1 N.O. 1 N.C.
Stackable Sealed Switch			
D1Y	O	X	1 N.O.
D2Y	X	O	1 N.C.
AY	O X	X O	1 N.O. - 1 N.C.

Note: X = Closed/O = Open
✶ Normally closed late break contact. When button is pushed from the OUT to IN position, the mechanical detent action of the operator occurs before electrical contacts change state. When the button is pulled from the IN in the OUT position, the electrical contacts change state before the mechanical detent occurs.
‡ Devices with N.C.L.B. contacts meet EN-418 and IEC 60947-5-5 standards for emergency stop applications.
§ Not valid with head Type J or JT.

10

Potentiometer Units∗❄

Potentiometer Unit
Cat. No. 800T-U24

Potentiometer Unit
Cat. No. 800H-UR4

Resistance	Type 4/13 Potentiometer‡ Cat. No.	Type 4/4X/13 Potentiometer‡ Cat. No.	Resistance	Type 4/13 Potentiometer‡ Cat. No.	Type 4/4X/13 Potentiometer‡ Cat. No.
Operator Only without Resistive Element	**800T-N37§**	**800H-N102§**	25 kΩ	**800T-U37**	800H-UR37
			50 kΩ	**800T-U41**	**800H-UR41**
150 Ω	**800T-U4**	**800H-UR4**	75 kΩ	800T-U46	800H-UR46
500 Ω	**800T-U12**	**800H-UR12**	100 kΩ	**800T-U49**	**800H-UR49**
1000 Ω	**800T-U13**	**800H-UR13**	150 kΩ	**800T-U50**	800H-UR50
1500 Ω	**800T-U16**	**800H-UR16**	400 kΩ	800T-U54	800H-UR54
2500 Ω	**800T-U19**	**800H-UR19**	500 kΩ	**800T-U55**	800H-UR55
5000 Ω	**800T-U24**	**800H-UR24**	1 MΩ	**800T-U57**	**800H-UR57**
10 kΩ	**800T-U29**	**800H-UR29**	2 MΩ	800T-U59	800H-UR59
15 kΩ	**800T-U34**	**800H-UR35**	3 MΩ	800T-U62	800H-UR62
20 kΩ	**800T-U35**	**800H-UR35**	4 MΩ	800T-U64	800H-UR64

∗ Single turn operation with 312° rotation.
❄ Does not meet Class 1 Div. 2 applications.
‡ Rated for 300V AC/DC, 2 W maximum. Specify Bulletin 800TC or 800HC for finger-safe potentiometers. Example: **Cat. No. 800T-U29** becomes **Cat. No. 800TC-U29**.
§ For use with Type J potentiometers having a shaft length of 7/8 in. (22.2 mm) and a shaft diameter of 1/4 in. (6.3 mm).

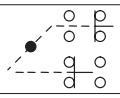
Mechanically Interlocked Maintained Push Button Units

Cat. No. 800T-FA22A

Cat. No. 800T-FB16A

Cat. No. 800T-FC16F

Cat. No. 800H-CRA22A

Contact Type	Configuration/ Position	Type 4/13 Button Position: Button Type/Color Upper: Flush/Black Lower: Flush/Black Cat. No.	Type 4/13 Upper: Flush/Green Lower: Extended/ Red Cat. No.	Type 4/13 Upper: Flush/Green Lower: Mushroom/ Red Cat. No.	Type 4/4X/13 Booted♣ Upper: Flush/Black Lower: Flush/Black Cat. No.	Type 4/4X/13 Bootless Upper: Flush/Green Lower: Extended/ Red Cat. No.	Type 4/4X/13 Bootless Upper: Flush/Black Lower: Flush/Black Cat. No.
1 N.O. - 1 N.C.		**800T-FA22A**	**800T-FB16A**	**800T-FC16A**	800H-FRA22A	800H-CRB16A	800H-CRA22A
2 N.O. - 2 N.C.		800T-FA22F	**800T-FB16F**	**800T-FC16F**	800H-FRA22F	800H-CRB16F	800H-CRA22F
No Contact	—	800T-FA22	800T-FB16	800T-FC16	800H-FRA22	800H-CRB16	800H-CRA22

♣ Boot material is hypalon with brass threaded insert. See page 10-37 for additional boot materials.

10

Contact Blocks

Packaged in kit form for field installation. All necessary mounting hardware is provided with each contact block kit. **Contact ratings are listed on page 10-4.**

Note: It is not recommended to mount more than four contact blocks on any one non-illuminated operator, (maximum two blocks deep). Contact blocks cannot be stacked onto power modules, so illuminated operators are limited to two contact blocks. Sealed switch contact blocks are not stackable, and are limited to two blocks per operator. Time delay contacts are only available as one circuit per operator.

Shallow Block

PenTUFF™ (Low Voltage) Contact Block

Logic Reed Block

Sealed Switch Block

Stackable Sealed Switch Block

Contact Type	Shallow Block∗❄		PenTUFF (Low Voltage) Block∗❄		Logic Reed Block‡		Sealed Switch Block‡		Stackable Sealed Switch Block‡	
	Cat. No.	Code	Cat. No.	Code	Cat. No.	Code	Cat. No.	Code	Cat. No.	Code
1 N.O.	**800T-XD1**	D	**800T-XD1V**	H	**800T-XD1R**	V	**800T-XD1P**	R	**800T-XD1Y**	5
1 N.C.	**800T-XD2**	E	**800T-XD2V**	U	**800T-XD2R**	W	**800T-XD2P**	S	**800T-XD2Y**	6
1 N.O.E.M.	**800T-XD3**	G	**800T-XD3V**	I	—	—	—	—	—	—
1 N.C.L.B.	**800T-XD4**	J	**800T-XD4V**	Q	—	—	—	—	—	—
1 N.O. - N.C.	**800T-XA**	A	**800T-XAV**	F	**800T-XAR**	T	**800T-XAP**	P	**800T-XAY**	7
2 N.O.	**800T-XA2§**	M	—	—	**800T-XA2R§**	Y	—	—	**800T-XA2Y**	8
2 N.C.	**800T-XA4**	N	—	—	**800T-XA4R**	Z	—	—	**800T-XA4Y**	9
1 N.C.L.B. - 1 N.O.	**800T-XA1**	B	—	—	—	—	—	—	—	—
1 N.C.L.B. - 1 N.C.	**800T-XA7**	C	—	—	—	—	—	—	—	—

Note: Modular suffix codes can be used when specifying selector switches with multiple contact blocks.

Self Monitoring Contact Block

Contact Type	S.M.C.B.∗➢
	Cat. No.
1 N.C.L.B. (wired in series with 1 N.O. monitoring contact)	**800TC-XD4S**

Mini Block

Time Delay Block

MaxDuty Block

Contact Type	Mini Block∗		Time Delay Block♣	MaxDuty Block	
	Cat. No.	Code	Cat. No.	Cat. No.	Code
1 N.O.	**800T-XD5**	K	**800T-XT**	**800T-XD1M**	1
1 N.C.	**800T-XD6**	L	800T-XS	**800T-XD2M**	2
1 N.C.L.B.	—	—	—	**800T-XD4M**	4

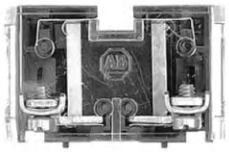
Note: Modular suffix codes can be used when specifying selector switches with multiple contact blocks.

∗ Contact blocks with normally closed contacts meet direct drive positive opening standard requirements when properly fused to IEC 269-1 and 269-2. Shallow/mini contacts: 10 A gl or N type cartridge fuse. PenTUFF contacts: 6 A gl or N type cartridge fuse.
❄ Specify Bulletin 800TC for finger-safe contact blocks. Example: **Cat. No. 800T-XA** becomes **Cat. No. 800TC-XA.**
‡ 800T operator using sealed switch and logic reed contact blocks and installed in a suitable enclosure are UL Listed as suitable for use in Class I, Division 2/Zone 2 hazardous locations.
§ Additional contacts cannot be stacked on XA2 and XA2R contact blocks.
♣ For contact ratings, see page 10-4.
➢ For use with 2-position push-pull or push-pull/twist operators only. Must be mounted on the first level of the operator. The N.O. monitoring contact automatically closes when the S.M.C.B. is properly installed onto the operator. If the S.M.C.B. is separated from the operator, the N.O. monitoring contact automatically opens.

Shallow Contact Block Hardware

Description	Cat. No.
Contact Block Mounting Screw	**800T-N335**
Screw Retainer	**800T-N336**
Actuator Extender	**800T-N337**

Power Modules



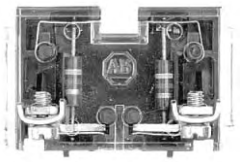
Full Voltage Power Module
Cat. No. 800T-N330

Transformer Power Module
Cat. No. 800T-N326

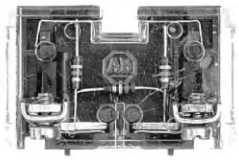
Dual Input Power Modules
Cat. No. 800T-N296 (Transformer)
Cat. No. 800T-N290N (Diode)

Full Voltage§		Transformer§		Dual Input		
Voltage	Cat. No.	Voltage	Cat. No.	Type	Voltage	Cat. No.
6V AC/DC 12V AC/DC 24V AC/DC 120V AC/DC	**800T-N330**	48V AC 50/60 Hz	800T-N325	Transformer✶	120V AC	800T-N296
		120V AC 50/60 Hz	**800T-N326**	Diode Type❄	24V AC/DC	800T-N290N
		240V AC 50/60 Hz	**800T-N327**		120V AC/DC	800T-N291N
		277V AC 50/60 Hz	800T-N327Y	—	—	—
		480V AC 50/60 Hz	**800T-N328**	—	—	—
240V AC/DC‡	800T-N331	600V AC 50/60 Hz	800T-N329	—	—	—

✶ Transformer type dual input provides circuit isolation via a miniature type relay. This module is used in conjunction with a 120V transformer.
❄ Diode type dual input provides circuit isolation via opposing diodes. Not recommended for use with solid-state outputs and neon indicators.
‡ 240V full voltage module contains 50% dropping resistors for use with a 120V incandescent lamp.
§ Specify Bulletin 800TC for finger-safe power modules. Example: **Cat. No. 800T-N330** becomes **800TC-N330.**



Resistor Power Module
Cat. No. 800T-N332



Neon Power Module
Cat. No. 800T-N333

Resistor (10% Drop)➢		Neon♣➢	
Voltage	Cat. No.	Voltage	Cat. No.
120V AC/DC	800T-N332	120V AC/DC	800T-N333
		240V AC/DC	800T-N334

♣ Neon modules contain resistors.
➢ Specify Bulletin 800TC for finger-safe power modules. Example: **Cat. No. 800T-N332** becomes **800TC-N332.**

10

Miscellaneous, Continued

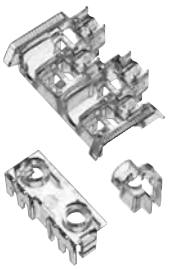
Photo	Description	Cat. No.
 *Cat. No. 800T-N323* *Cat. No. 800T-N324* *Cat. No. 800T-N322* *IEC Finger-Safe Accessories*	**800T/H** **IEC Finger-Safe Terminal Guards** Snap-on accessories which provide IEC, IP2X and VGB finger-safe protection. Single terminal guards for single circuit contact blocks, full voltage modules, LED modules, etc. (800T-XD1, -XD2, -XD3, -XD4, -XD5, -XD6, -XAP, -XD1P, -XD2P, -PC..., and -QC...)∗ **Note:** Must be ordered in multiples of 100 pieces.	**800T-N322**
	Transformer covers for transformer only. **Note:** Must be ordered in multiples of 25 pieces.	**800T-N324**
	Multi-terminal side cover for use on single or double circuit contact blocks. (800T-XA, -XA1, -XA2, -XA4, -XA7, -XAR, -XA2R, -XA4R, -XD1R, and -XD2R) **Note:** Must be ordered in multiples of 25 pieces.	**800T-N323**
Cat. No. 800T-N292	**Gray 800T** **Trim Washer** Used to mount the operator properly when a legend plate is not being used. **Note:** Must be ordered in multiples of 10 pieces.	**800T-N292**
	Plastic 800H **Trim Washer** Used to mount the operator properly when a legend plate is not being used. **Note:** Must be ordered in multiples of 10 pieces.	800H-N148
Cat. No. 800T-N293	**Metal 800T** **Thrust Washer** Used to prevent rotation of operators in a keyed or notched hole. **Note:** Must be ordered in multiples of 10 pieces.	**800T-N293**
	Plastic 800H **Thrust Washer** Used to prevent rotation of operators in a keyed or notched hole. **Note:** Must be ordered in multiples of 10 pieces.	800H-N146
Cat. No. 800T-N188	**800T** **Etching Fluid** Used to blacken freshly engraved aluminum legend plates.	**800T-N188**

Photo	Description	Color	Cat. No.
Cat. No. 800T-N1	**800T/H** **Closing Button** Where an enclosure or flush plate with more than the required number of openings is used, this neat-appearing button can be supplied to close the unused openings.	Grey	**800T-N1**
		Black	**800T-N1B**

∗ Power modules excluding transformers and dual inputs

10

Replacement Lamps

Pilot Lights, Illuminated Push Buttons, Illuminated Push-Pull, Illuminated Push-Pull/Twist to Release

Lamp	Type	Current, Typical	Lamp Voltage	ANSI No.		Cat. No.
Incandescent	Full Voltage Transformer	150 mA/250 mA	6.3V AC	755/1866	✶	**800T-N65**
	Full Voltage	80 mA	14V AC/DC	756	✶	800T-N141
		70 mA	24V AC/DC	757	✶	**800T-N157**
		50 mA	48V AC/DC	1835	✶	800T-N365
	Full Voltage Resistor	22 mA	120V AC/DC	949	✶	**800T-N169**
	Flashing	150 mA	6V AC/DC	267	✶	**800T-N212**
	Dual Input Diode	57 mA	24V AC/DC	24MB	✶	800T-N180
		21 mA	120V AC	90MB	✶	800T-N261
Neon	—	2 mA	120V AC/DC	B2A		**609-N9**
Lamp	**Type**	**Current, Typical❄**	**Lamp Voltage**	**Leakage Current**		**Cat. No.§**
LED‡	Full Voltage	13 mA/22 mA	12V AC/DC	3 mA		800T-N362x
		13 mA/21 mA	24V AC/DC	3 mA		**800T-N319x**
		12 mA/17 mA	32V AC/DC	3 mA		800T-N363x
		9 mA/14 mA	48V AC/DC	3 mA		800T-N364x
		3.3 mA/6 mA	120V AC	—		**800T-N320x**
		4.5 mA/6.2 mA	130V AC/DC	3 mA		**800T-N321x**
	Transformer	50 mA	6V AC	14 mA		**800T-N318x**
	Flashing	18 mA	24V AC/DC	—	♣	800T-N319Fx

Illuminated Selector Switches

Lamp	Type	Current, Typical	Lamp Voltage	ANSI No.	Cat. No.✶
Incandescent	Full Voltage Transformer	150 mA/250 mA	6.3V AC	755/1866	**800T-N65**
	Full Voltage	80 mA	14V AC/DC	756	800T-N141
		70 mA	24V AC/DC	757	**800T-N157**
Lamp	**Type**	**Current, Typical❄**	**Lamp Voltage**	**Leakage Current**	**Cat. No.§**
LED‡	Full Voltage	13 mA/22 mA	12V AC/DC	3 mA	800T-N362x
		13 mA/21 mA	24V AC/DC	3 mA	**800T-N319x**
		12 mA/17 mA	32V AC/DC	3 mA	800T-N363x
		9 mA/14 mA	48V AC/DC	3 mA	800T-N364x
		3.3 mA/6 mA	120V AC	—	**800T-N320x**
		4.5 mA/6.2 mA	130V AC/DC	3 mA	**800T-N321x**
		14 mA/48 mA	6V AC	14 mA	**800T-N318x**
	Flashing	18 mA	24V AC/DC	—	♣ 800T-N319Fx

Cluster Pilot Lights

Lamp	Type	Current, Typical	Lamp Voltage	ANSI No.	Cat. No.✶
Incandescent	Full Voltage Transformer	195 mA	6V AC/DC	381	**800T-N258**
	Full Voltage	73 mA	12V AC/DC	382	800T-N259
		37 mA	24V AC/DC	387	**800T-N260**
Lamp	**Type**	**Current, Typical**	**Lamp Voltage**	**Polarity**	**Cat. No.➢**
LED	Full Voltage Transformer	45 mA	6V AC/DC	Positive	**800T-N340x**
	Full Voltage	36 mA	12V AC/DC	Positive	**800T-N341x**
		14 mA	28V AC/DC	Bi-Polar	**800T-N80x**

✶ Item is sold in multiples of 5. Order quanitity of 5 to receive package of 5 pieces.
❄ Typical current draw varies with LED color. The first mA value is for a green or blue LED and the second mA value is for a red or amber LED.
‡ All LEDs except 120V have an internal shunt resistor for use with solid-state outputs. LEDs will not illuminate below listed leakage current.
§ To complete the cat. no. replace the **x** with the first letter of the desired color: **A**mber, **G**reen, **R**ed, **B**lue, or **W**hite. White LEDs only available in 6, 24, 120, and 130V.
♣ Flashing rate is 2 Hz.
➢ To complete the cat. no., replace the **x** with the first letter of the desired color: **A**mber, **G**reen, or **R**ed only.

Blank and Custom Legend Plates — Aluminum, Type 4/13 (800T)

Blank/Custom Legend Plates

Standard Legend Plate

Jumbo Legend Plate

Legend Plate Color	Standard Cat. No.	Jumbo Cat. No.
Grey	**800T-X559**	**800T-X559J**
Red	**800T-X621**	**800T-X621J**
Yellow	**800T-X679**	800T-X679J
Grey (with Custom Text)	800T-X559E	800T-X559JE
Red (with Custom Text)	800T-X621E	800T-X621JE
Yellow (with Custom Text)	800T-X679E	800T-X679JE

Specialty Legend Plates

Automotive Legend Plate

Half Round Legend Plate

Legend Plate Color	Automotive Cat. No.	Half Round∗ Cat. No.
Grey (Blank)	**800T-X700**	800T-X59
Red (Blank)	800T-X701	800T-X121
Grey (with Custom Text)	800T-X700E	800T-X59E
Red (with Custom Text)	800T-X701E	800T-X121E

Note: Include text with custom legends.
∗ All half round legend plates must be ordered in quantities of 25.

Custom Text Guidelines

Legend Size	No. of Lines	Max. No. of Characters per Line
Standard	1 Line of 2 Lines of	14 14
Jumbo	5 Lines	14
Automotive	4 Lines	20

Custom Legend Plates for 4 Way Toggle and Cluster Pilot Lights

Legend Size	Cat. No.‡	Color	Text Options❄
Standard	800T-X619E	Aluminum (with Custom Text)	2 lines of up to 14 characters on top 1 line of up to 14 characters on bottom 1 vertical line of up to 7 characters on left side 1 vertical line of up to 7 characters on right side
			1 vertical line of up to 9 characters on left side 1 vertical line of up to 9 characters on right side

❄ Rule sets listed are mutually exclusive; only one can be chosen.
‡ For blank toggle or cluster pilot legend, order Cat. No. 800T-X619.

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Bulletin 1492-FB — DIN Rail Mounting Fuse Holders

- Compact size requiring less panel space than open-style fuse holders
- Handle isolates the fuse from power when installing or removing fuse
- IP2 — Front-finger protection per IEC/EN 60529
- Optional blown fuse indicators — allow easy troubleshooting of electrical circuits
- Easy insertion/removal of fuses, no special tools required
- Mounts on standard 35 mm DIN Rail
- Marker-ready
- Terminals shipped in open position and are ready for wiring

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Product Selection..... this page
Approximate Dimensions..... 7-30

Standards Compliance

UL 512
CSA 22.2 No. 39
EN/IEC 60947-3
EN/IEC 60269-2-1

Certifications

UL Listed
UR Recognized Component
CSA Certified
CE Marked

Bulletin 1492-FB fuse holders provide a safe and convenient means for installation of class CC, J, and midget fuses. The class CC fuse holder is designed to reject a midget fuse or international 10 x 38 mm fuse. The class J fuse holder will reject all fuses other than a class J fuse.

The class CC and J holders are UL Listed and CSA Certified for branch circuit protection. Class CC and J fuses are excellent for wire protection, small motor loads, and group protection of small motor loads. The midget holders are UL Recognized and CSA Certified when supplementary (1-1/2 in. x 13/32 in.) fuses are applied. The midget fuse holder is also CE Marked for 10 x 38 mm IEC midget fuses.

The 1492-FB fuse holder family is designed for use in many OEM applications, such as power supplies, equipment protection, primary and secondary control transformers, solenoids, lighting and heater loads, and drives.

Product Selection

		For Class CC Fuse	For Class J Fuse		For Midget Fuse
		30 A∗	30 A	60 A	30 A
Description		Cat. No.	Cat. No.	Cat. No.	Cat. No.
One-Pole	1-Pole Fuse Block	**1492-FB1C30**	**1492-FB1J30**	**1492-FB1J60**	**1492-FB1M30**
	1-Pole Fuse Block with Indication	**1492-FB1C30-L**	**1492-FB1J30-L**	**1492-FB1J60-L**	**1492-FB1M30-L**
	1-Pole Fuse Block with Indication, 12…72V	**1492-FB1C30-D1**	—	—	**1492-FB1M30-D1**
	Pieces per Carton	6			
Two-Pole	2-Pole Fuse Block	**1492-FB2C30**	**1492-FB2J30**	**1492-FB2J60**	**1492-FB2M30**
	2-Pole Fuse Block with Indication	**1492-FB2C30-L**	**1492-FB2J30-L**	**1492-FB2J60-L**	**1492-FB2M30-L**
	Pieces per Carton	3			
Three-Pole	3-Pole Fuse Block	**1492-FB3C30**	**1492-FB3J30**	**1492-FB3J60**	**1492-FB3M30**
	3-Pole Fuse Block with Indication	**1492-FB3C30-L**	**1492-FB3J30-L**	**1492-FB3J60-L**	**1492-FB3M30-L**
	Pieces per Carton	2			

∗ All major fuse brands and current ranges have been evaluated for this fuse holder. Due to the heat they generate, the following fuses must be derated:
Ferraz Shamut ATQR 1.25 / = 0.42 A max.
Ferraz Shamut ATQR 1.40 / = 0.47 A max.

Specifications

			For Class CC Fuse	For Class J Fuse		For Midget Fuse
			30 A	30 A	60 A	30 A
Certifications			UL, CSA, CE			UR, CSA, CE
Maximum Voltage Rating			600V AC/DC			
Fuse Withstand Rating			200 kA			50 kA
Fuse Reject Feature			Yes			No
Operating Temperature			–4…+130 °F (–20…+55 °C)			
Contact Material			Silver, Ag			
With Indicator	Working Voltage	LED	110...600V AC/DC or 12…72V DC	110...600V AC/DC		110...600V AC/DC or 12...72V AC/DC
	Leakage Current	LED	2.0 mA			
Wire Size			#16…4 AWG Cu	#14…1 AWG Cu	#10...1 AWG Cu	#16…4 AWG Cu
Recommended Wire Strip Length			0.44 in. (11 mm)	0.8 in. (20 mm)		0.44 in. (11 mm)
Terminal Torque			2...2.5 N•m (18...22 lb•in)	3.5...4 N•m (31...35 lb•in)		2...2.5 N•m (18...22 lb•in)

Accessories

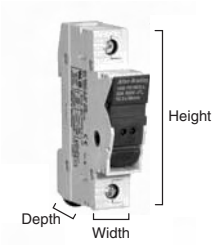
Description	Pkg. Quantity	Cat. No.
Fuseholder Identification Slide-in Markers∗ The following are blank cards. Squares slip into molded slot.	5	**1492-MC5X5** **1492-MC6X5**

∗ Refer to terminal block marking systems on page 12-82 .

7

Approximate Dimensions

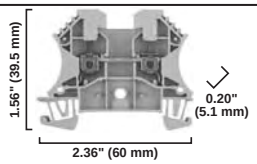
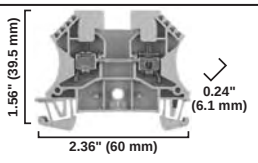
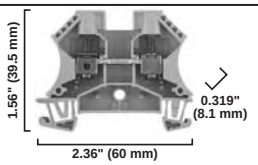
Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.



Dimension		For Class CC Fuse	For Class J Fuse		For Midget Fuse
		30 A	30 A	60 A	30 A
Height		3.19 in. (81 mm)	4.65 in. (118 mm)	4.65 in. (118 mm)	3.19 in. (81 mm)
Depth		2.51 in. (64 mm)	2.76 in. (70 mm)	3.23 in. (82 mm)	2.51 in. (64 mm)
Width	One-Pole	0.71 in. (18 mm)	1.41 in. (36 mm)	1.57 in. (40 mm)	0.71 in. (18 mm)
	Two-Pole	1.41 in. (36 mm)	2.83 in. (72 mm)	3.15 in. (80 mm)	1.41 in. (36 mm)
	Three-Pole	2.13 in. (54 mm)	4.25 in. (108 mm)	4.72 in. (120 mm)	2.13 in. (54 mm)

Screw Connection Terminal Blocks

Standard Feed-Though Blocks

	1492-J3				1492-J4				1492-J6			
Dimensions are not intended to be used for manufacturing purposes. **Note:** Height dimension is measured from top of rail to top of terminal block.												
Specifications	*Feed-Through Terminal Block*				*Feed-Through Terminal Block*				*Feed-Through Terminal Block*			
Certifications	cULus	CSA	IEC	ATEX	cULus	CSA	IEC	ATEX	cULus	CSA	IEC	ATEX
Voltage Rating	600V AC/DC		800V AC/DC	550V AC/DC	600V AC/DC		800V AC/DC	690V AC/DC	600V AC/DC		800V AC/DC	550V AC/DC
Maximum Current	65 A	50 A	24 A	21 A	35 A	25 A	32 A	28 A	50 A		41 A	36 A
Wire Range (Rated Cross Section)	#22…12 AWG	#26…12 AWG	2.5 mm²	2.5 mm² (#20…14 AWG)	#22…10 AWG	#26…10 AWG	4 mm²	4 mm² (#20…12 AWG)	#22…8 AWG		6 mm²	6 mm² (#20…10 AWG)
Wire Strip Length	0.39 in. (10 mm)				0.39 in. (10 mm)				0.47 in (12 mm)			
Recommended Tightening Torque	4.5…7.1 lb•in. (0.5…0.8 N•m)				9.0 lb•in. (1.0 N•m)				14.2 lb•in (1.6 N•m)			
Density	59 pcs/ft (196 pcs/m)				49 pcs/ft (163 pcs/m)				37 pcs/ft (123 pcs/m)			
Housing Temperature Range	–58…+248 °F (–50…+120 °C)				–58…+248 °F (–50…+120 °C)				–58…+248 °F (–50…+120 °C)			
Short-Circuit Current Rating	See page 12-43											
Terminal Blocks	**Cat. No.**		**Pkg Qty.**		**Cat. No.**		**Pkg Qty.**		**Cat. No.**		**Pkg Qty.**	
Color: Grey	**1492-J3**		100		**1492-J4**		100		**1492-J6**		100	
Red	**1492-J3-RE**		100		**1492-J4-RE**		100		**1492-J6-RE**		100	
Blue	**1492-J3-B**		100		**1492-J4-B**		100		**1492-J6-B**		100	
Black	**1492-J3-BL**		100		**1492-J4-BL**		100		**1492-J6-BL**		100	
Green	**1492-J3-G**		100		**1492-J4-G**		100		**1492-J6-G**		100	
Yellow	**1492-J3-Y**		100		**1492-J4-Y**		100		**1492-J6-Y**		100	
Orange	**1492-J3-OR**		100		**1492-J4-OR**		100		**1492-J6-OR**		100	
Brown	**1492-J3-BR**		100		**1492-J4-BR**		100		**1492-J6-BR**		100	
White	**1492-J3-W**		100		**1492-J4-W**		100		**1492-J6-W**		100	
Accessories	**Cat. No.**		**Pkg Qty.**		**Cat. No.**		**Pkg Qty.**		**Cat. No.**		**Pkg Qty.**	
Mounting Rails: 1 m Symmetrical DIN (Steel)	**199-DR1**		10		**199-DR1**		10		**199-DR1**		10	
1 m Symmetrical DIN (Aluminum)	**1492-DR5**		10		**1492-DR5**		10		**1492-DR5**		10	
1 m Hi-Rise Sym. DIN (Aluminum)	**1492-DR6**		2		**1492-DR6**		2		**1492-DR6**		2	
1 m Angled Hi-Rise Sym. DIN (Steel)	**1492-DR7**		2		**1492-DR7**		2		**1492-DR7**		2	
End Barriers Grey	**1492-EBJ3**		50		**1492-EBJ3**		50		**1492-EBJ3**		50	
Blue	**1492-EBJ3-B**		50		**1492-EBJ3-B**		50		**1492-EBJ3-B**		50	
Yellow	**1492-EBJ3-Y**		50		**1492-EBJ3-Y**		50		**1492-EBJ3-Y**		50	
End Anchors and Retainers: Screwless End Retainer	**1492-ERL35**		20		**1492-ERL35**		20		**1492-ERL35**		20	
DIN Rail — Normal Duty	**1492-EAJ35**		100		**1492-EAJ35**		100		**1492-EAJ35**		100	
DIN Rail — Heavy Duty	**1492-EAHJ35**		50		**1492-EAHJ35**		50		**1492-EAHJ35**		50	
Jumpers:* Screw Center Jumper — 10-pole	**1492-CJJ5-10**		20		**1492-CJJ6-10**		20		**1492-CJJ8-10**		20	
Screw Center Jumper — 4-pole	**1492-CJJ5-4**		50		**1492-CJJ6-4**		50		**1492-CJJ8-4**		50	
Screw Center Jumper — 3-pole	**1492-CJJ5-3**		50		**1492-CJJ6-3**		50		**1492-CJJ8-3**		50	
Screw Center Jumper — 2-pole	**1492-CJJ5-2**		50		**1492-CJJ6-2**		50		**1492-CJJ8-2**		50	
Plug-in Center Jumper — 50-Pole	**1492-CJLJ5-50**		10		**1492-CJLJ6-41** (41-pole)		10		—		—	
Plug-in Center Jumper — 10-Pole	**1492-CJLJ5-10**		20		**1492-CJLJ6-10**		20		—		—	
Plug-in Center Jumper — 9-Pole	**1492-CJLJ5-9**		20		—		—		—		—	
Plug-in Center Jumper — 8-Pole	**1492-CJLJ5-8**		20		—		—		—		—	
Plug-in Center Jumper — 7-Pole	**1492-CJLJ5-7**		20		—		—		—		—	
Plug-in Center Jumper — 6-Pole	**1492-CJLJ5-6**		20		—		—		—		—	
Plug-in Center Jumper — 5-Pole	**1492-CJLJ5-5**		20		—		—		—		—	
Plug-in Center Jumper — 4-Pole	**1492-CJLJ5-4**		60		**1492-CJLJ6-4**		60		—		—	
Plug-in Center Jumper — 3-Pole	**1492-CJLJ5-3**		60		**1492-CJLJ6-3**		60		—		—	
Plug-in Center Jumper — 2-Pole	**1492-CJLJ5-2**		60		**1492-CJLJ6-2**		60		—		—	
Insulated Side Jumper — 24-Pole	**1492-SJ5B-24**		50		—		—		—		—	
Insulated Side Jumper — 10-Pole	**1492-SJ5B-10**		50		—		—		—		—	
Screw Type Jumper Notching Tool	**1492-T1**		1		**1492-T1**		1		**1492-T1**		1	
Other Accessories: Partition Plate	**1492-EBJ16**		20		**1492-EBJ16**		20		**1492-EBJ16**		20	
Test Plug Socket	**1492-TPS23**		20		**1492-TPS23L**		50		**1492-TPS23L**		50	
Test Plug	**1492-TP23**		20		**1492-TP23**		20		**1492-TP23**		20	
Test Plug (Stackable)	**1492-TPJ5**		25		**1492-TPJ6**		25		—		—	
Electrical Warning Plate	**1492-EWPJ5**		25		**1492-EWPJ5**		25		**1492-EWPJ8**		50	
Group Marking Carrier	**1492-GM35**		25		**1492-GM35**		25		**1492-GM35**		25	
Marking Systems: Snap-in Marker Cards	**1492-M5X12** (144/card)	**1492-M5X5** (200/card)	5	5	**1492-M6X12** (120/card)	**1492-M6X5** (200/card)	5	5	**1492-MR8X12** (84/card)	**1492-M8X5** (160/card)	5	5

* Use of center jumpers may affect spacings, requiring derating of terminal blocks. See page 12-78 for details.

IEC Terminal Block Accessories

Specifications

In general, accessories for terminal blocks are not eligible for recognition by UL, CSA, or other third party approval aggencies. The suitability of the installation must be judged in the end use application due to the wide variety of possible uses. However, accessories are designed to meet, and are tested to, the terminal block assembly requirements such as electrical spacings, etc.

Maximum number of multiple wire connections for copper conductors of the same cross-section and type for Allen-Bradley IEC Terminal Blocks.
Cat. Nos. 1492-J and L products are all recommended for one conductor per terminal. Wire range is defined in the cat. page for each of the products.

	Wire Size [AWG]																		
	#30	#28	#26	#24	#22	#20	#18	#16	#14	#12	#10	#8	#6	#4	#2	#1	1/0	2/0	3/0
Cat. No.	Number of the Same Size Wires Per Terminal																		
1492-H4	—	—	—	—	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-H5	—	—	—	—	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-H6	—	—	—	—	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-H7	—	—	—	—	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-J2Q	—	—	4	4	4	3	1	1	1	—	—	—	—	—	—	—	—	—	—
1492-J3	4	4	4	4	4	4	3	3	2	1	—	—	—	—	—	—	—	—	—
1492-J3F	4	4	4	4	4	4	3	3	2	1	—	—	—	—	—	—	—	—	—
1492-J3TW (Single Side)	4	4	4	4	4	4	3	3	2	1	—	—	—	—	—	—	—	—	—
1492-J3TW (Twin Side)	—	—	4	4	4	3	1	1	1	—	—	—	—	—	—	—	—	—	—
1492-J4	—	—	—	—	4	4 (29 A)	3	3	2	1	1	—	—	—	—	—	—	—	—
1492-J4M	—	—	—	—	4	4 (29 A)	3	3	2	1	1	—	—	—	—	—	—	—	—
1492-J6	—	—	—	—	4	4 (30 A)	3	3	3	2	1	1	—	—	—	—	—	—	—
1492-J10	—	—	—	—	4	4	4	4 (46 A)	3 (50 A)	2 (50 A)	1	1	1	—	—	—	—	—	—
1492-J16	—	—	—	—	—	—	—	4 (67 A)	4 (62 A)	3 (71 A)	2 (67 A)	1	1	1	—	—	—	—	—
1492-J35	—	—	—	—	—	—	—	—	3	3	3 (90 A)	2	2 (114 A)	1	1	1	1	—	—
1492-J50	—	—	—	—	—	—	—	—	—	—	—	2	2	1	1	1	1	—	—
1492-J70*	—	—	—	—	—	—	—	—	5	5	5	2	2	2	1	1	1	1	—
1492-JC3	—	—	4	4	4	3	1	1	1	—	—	—	—	—	—	—	—	—	—
1492-JD3...	4	4	4	4	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-JD3F	4	4	4	4	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-JD3P	—	—	—	—	4	4	3	2	1	1	—	—	—	—	—	—	—	—	—
1492-JDC3	4	4	4	4	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-JDG3	4	4	4	4	4	4	3	2	2	1	—	—	—	—	—	—	—	—	—
1492-JDG3P	—	—	—	—	4	4	3	2	1	1	—	—	—	—	—	—	—	—	—
1492-JG2Q	—	—	4	4	4	3	1	1	1	—	—	—	—	—	—	—	—	—	—
1492-JG3	4	4	4	4	4	4	3	3	2	1	—	—	—	—	—	—	—	—	—

Current Transformer
Models 21, 22, 23, 24, 25
Window Diameter 1.25", 1.63", 2.00", 2.50", 3.13"

REGULATORY AGENCY APPROVALS
E93779 LR89403
Manufactured to meet the requirements of ANSI/IEEE C57.13.
Classified by U.L. in accordance with IEC 44-1

Model 22

APPLICATION:
Relaying and metering.

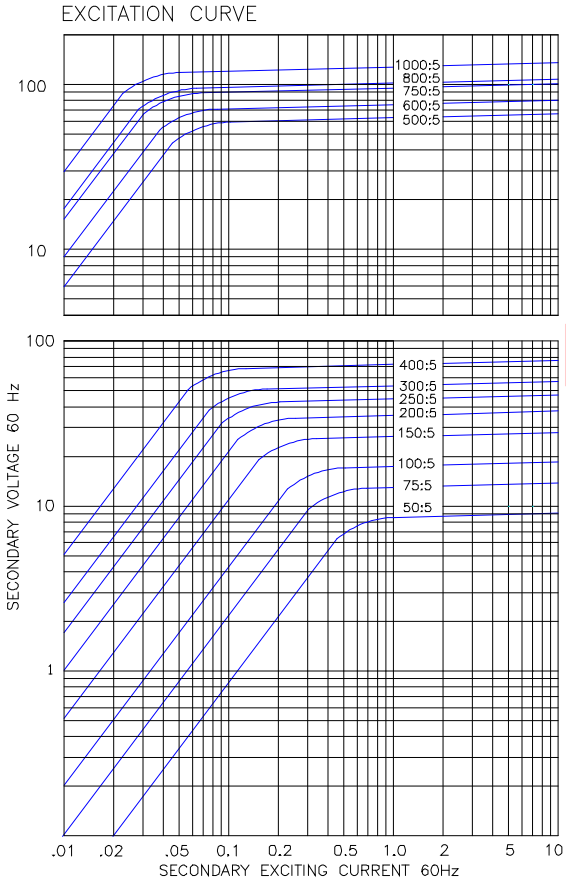
FREQUENCY:
50-400 Hz.

INSULATION LEVEL:
600 Volts, 10 kV BIL full wave.

Terminals are brass studs No. 8-32 with one flatwasher, lockwasher and regular nut.

Order mounting bracket kit 0221B00541 separately.

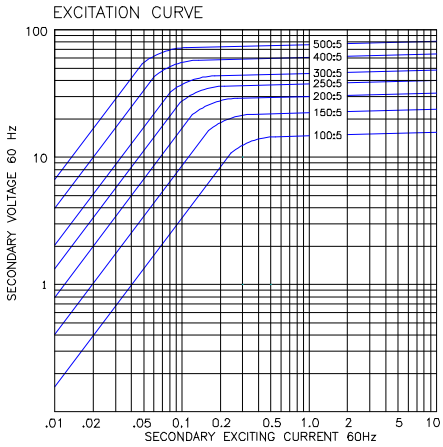
Multi-ratios available upon request.



Model 21 *Window Diameter 1.25"*

Approximate weight 10 lbs.

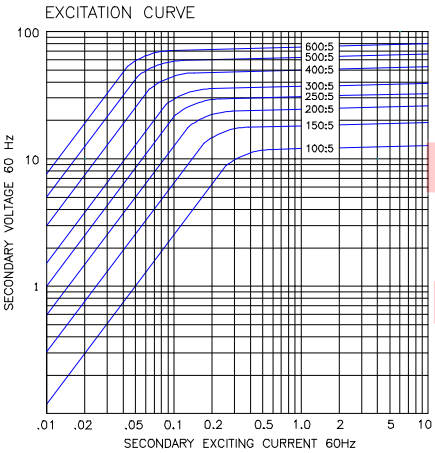
CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE (OHMS @ 75°C)	CONTINUOUS THERMAL RATING FACTOR	
			B0.1	B0.2	B0.5	B0.9	B1.8		@ 30°C	@ 55°C
21—500	50:5	—	1.2	2.4	—	—	—	0.026	2.0	2.0
21—750	75:5	C10	0.6	1.2	2.4	4.8	—	0.042	2.0	2.0
21—101	100:5	C10	0.6	1.2	1.2	2.4	4.8	0.063	2.0	2.0
21—151	150:5	C20	0.3	0.6	0.6	1.2	2.4	0.098	2.0	1.5
21—201	200:5	C20	0.3	0.3	0.6	0.6	1.2	0.126	2.0	1.5
21—251	250:5	C20	0.3	0.3	0.3	0.6	1.2	0.158	1.5	1.5
21—301	300.5	C20	0.3	0.3	0.3	0.3	0.6	0.168	1.5	1.33
21—401	400:5	C50	0.3	0.3	0.3	0.3	0.6	0.253	1.5	1.0
21—501	500:5	C20	0.3	0.3	0.3	0.3	0.6	0.283	1.5	1.0
21—601	600.5	C50	0.3	0.3	0.3	0.3	0.3	0.339	1.33	1.0
21—751	750.5	C50	0.3	0.3	0.3	0.3	0.3	0.424	1.0	0.8
21—801	800.5	C50	0.3	0.3	0.3	0.3	0.3	0.452	1.0	0.8
21—102	1000.5	C100	0.3	0.3	0.3	0.3	0.3	0.565	1.0	0.8



Model 22 *Window Diameter 1.63”*

Approximate weight 9 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			B0.1	B0.2	B0.5	B0.9	B1.8	(OHMS @ 75°C)	@ 30°C	@ 55°C
22—101	100:5	C10	0.6	1.2	2.4	2.4	4.8	0.060	2.0	2.0
22—151	150:5	C10	0.3	0.6	1.2	1.2	2.4	0.090	2.0	2.0
22—201	200:5	C20	0.3	0.3	0.6	1.2	1.2	0.120	2.0	1.5
22—251	250:5	C20	0.3	0.3	0.6	0.6	1.2	0.150	1.5	1.5
22—301	300:5	C20	0.3	0.3	0.3	0.6	0.6	0.180	1.5	1.33
22—401	400:5	C20	0.3	0.3	0.3	0.3	0.6	0.241	1.5	1.0
22—501	500:5	C50	0.3	0.3	0.3	0.3	0.3	0.301	1.5	1.0



Model 23 *Window Diameter 2.00”*

Approximate weight 8.5 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			B0.1	B0.2	B0.5	B0.9	B1.8	(OHMS @ 75°C)	@ 30°C	@ 55°C
23—101	100:5	—	0.6	0.6	2.4	4.8	—	0.051	2.0	2.0
23—151	150:5	C10	0.6	0.6	0.6	1.2	2.4	0.076	2.0	2.0
23—201	200:5	C10	0.3	0.6	0.6	1.2	2.4	0.114	2.0	1.5
23—251	250:5	C20	0.3	0.3	0.6	0.6	1.2	0.143	2.0	1.5
23—301	300:5	C20	0.3	0.3	0.3	0.6	1.2	0.171	1.5	1.33
23—401	400:5	C20	0.3	0.3	0.3	0.3	0.6	0.226	1.5	1.0
23—501	500:5	C50	0.3	0.3	0.3	0.3	0.3	0.286	1.5	1.0
23—601	600:5	C50	0.3	0.3	0.3	0.3	0.3	0.343	1.33	1.0

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Fax: +1-905-201-2455
e-mail: sales.multilin@ge.com

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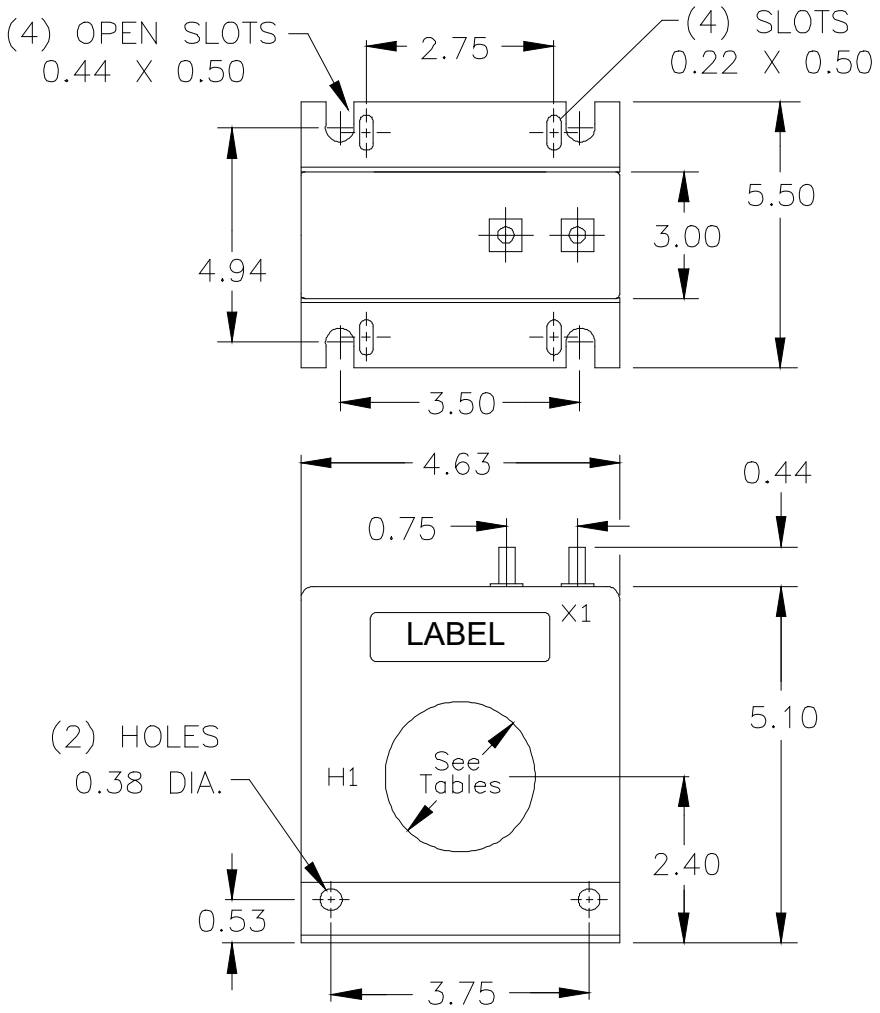
Tel: +34-94-485-88-00
Fax: +34-94-485-88-45
e-mail: gemultilin.euro@ge.com



Outline - Models 21, 22, 23, 24, 25

USA, Canada, Asia, Latin America
Tel: +1-800-547-8629
Fax: +1-905-201-2455
e-mail: sales.multilin@ge.com

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Tel: +34-94-485-88-00
Fax: +34-94-485-88-45
e-mail: gemultilin.euro@ge.com

Ferraz Shawmut

GROUPE CARBONE LORRAINE

Your Circuit Protection Resource

Medium Voltage Fuses

FERRAZ SHAWMUT CANADA Inc.

MEDIUM VOLTAGE AMP-TRAP FUSE

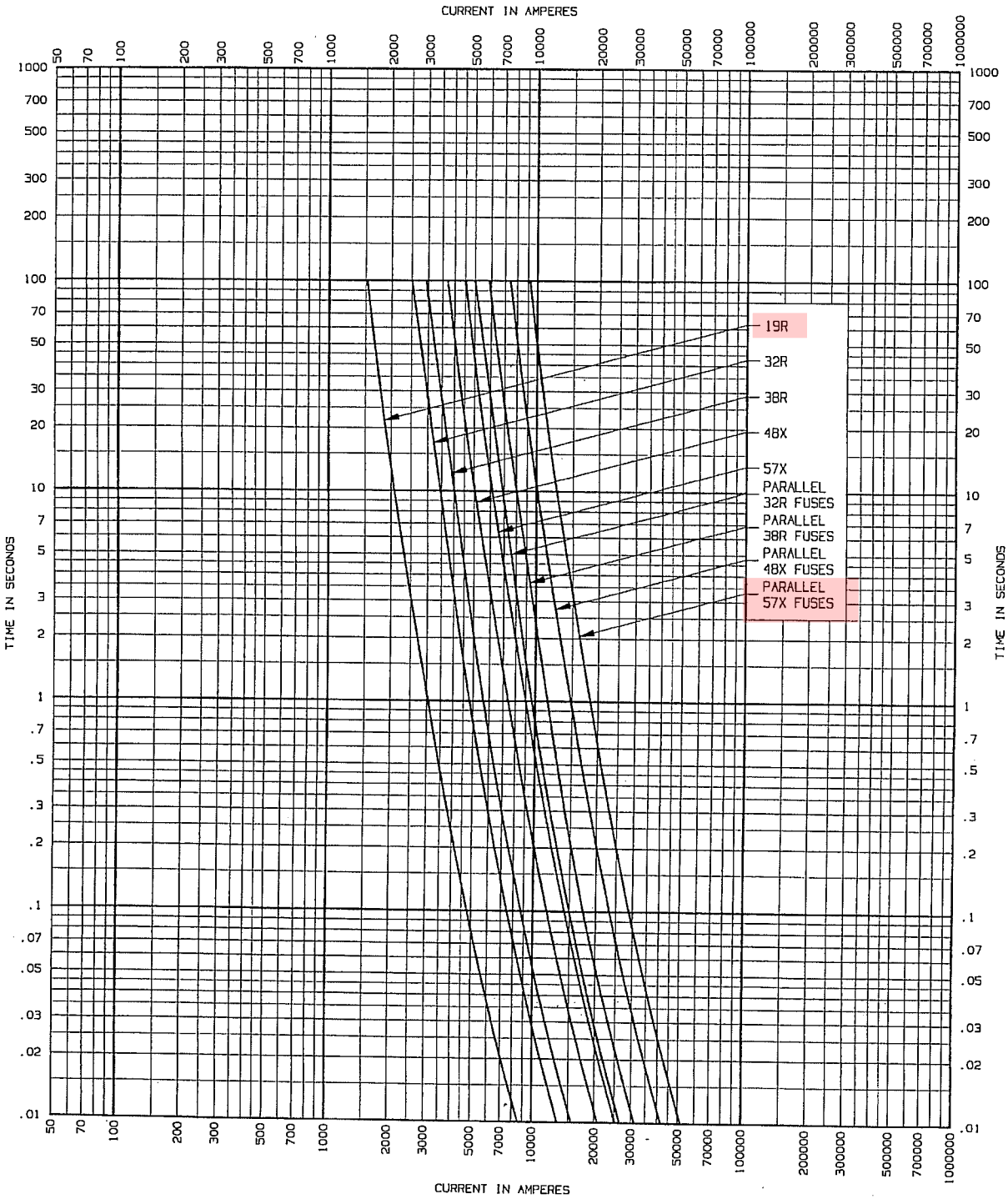
CAT. NO. A051B1DARO-19R
A051B2DARO-32R
A051B2DARO-38R
A051B3DARO-48X
A051B3DARO-57X
19R & 38R 5.5KV MAX
48X & 57X 5.2KV MAX

CONTROL NO: 730
FOLDER NO. 5D
REV. E
2/10/05

MINIMUM MELTING TIME-CURRENT CURVE

FERRAZ SHAWMUT
NEWBURYPORT, MA 01950

102657



MEDIUM VOLTAGE AMP-TRAP FUSE

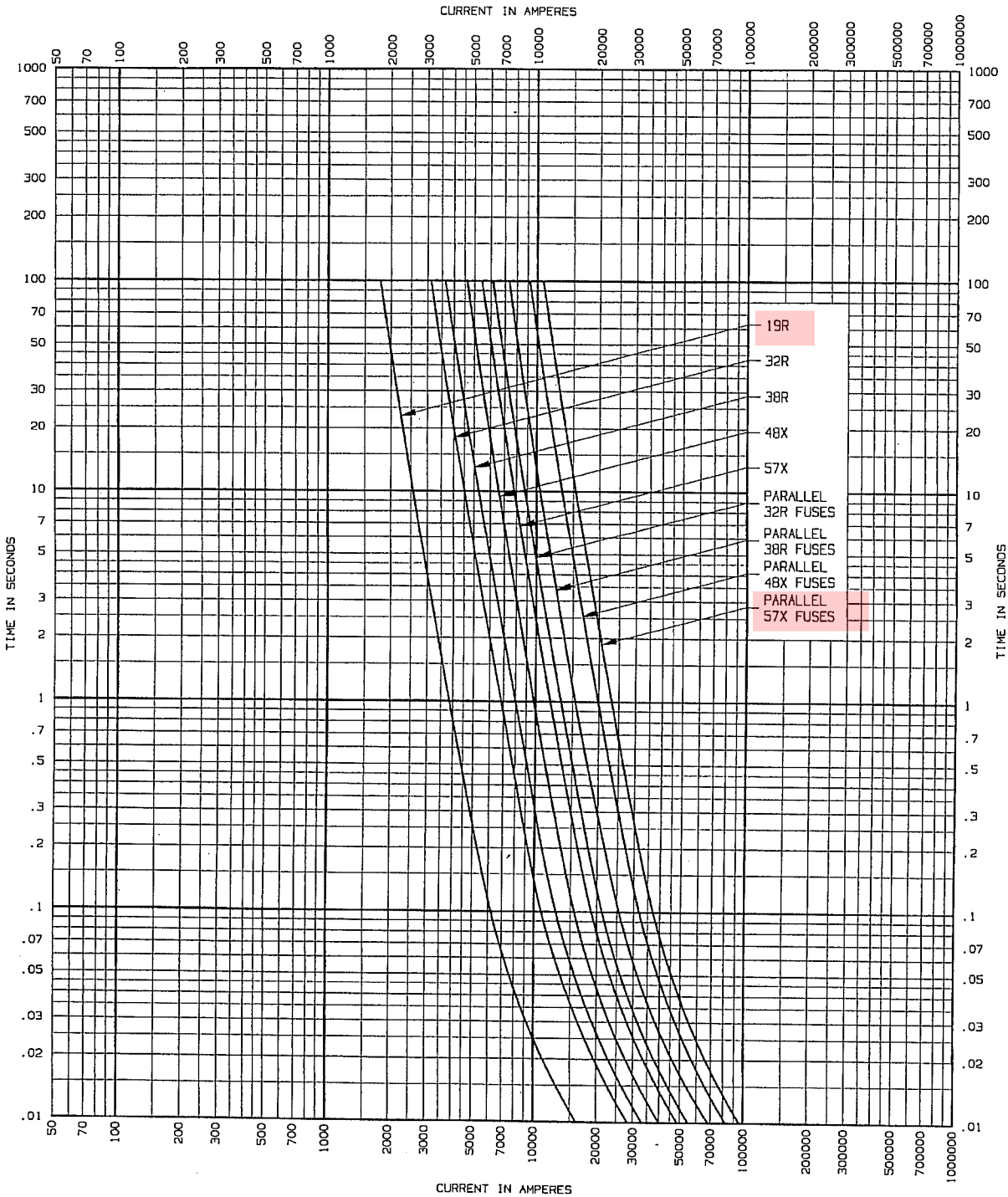
CONTROL NO: 730
FOLDER NO. 50
REV. E
2/10/05

CAT. NO. A051B1DARD-19R
A051B2DARD-32R
A051B2DARD-38R
A051B3DARD-48X
A051B3DARD-57X
19R & 38R 5.5KV MAX
48X & 57X 5.2KV MAX

TOTAL CLEARING TIME-CURRENT CURVE

FERRAZ SHAWMUT
NEWBURYPORT, MA 01950

102656



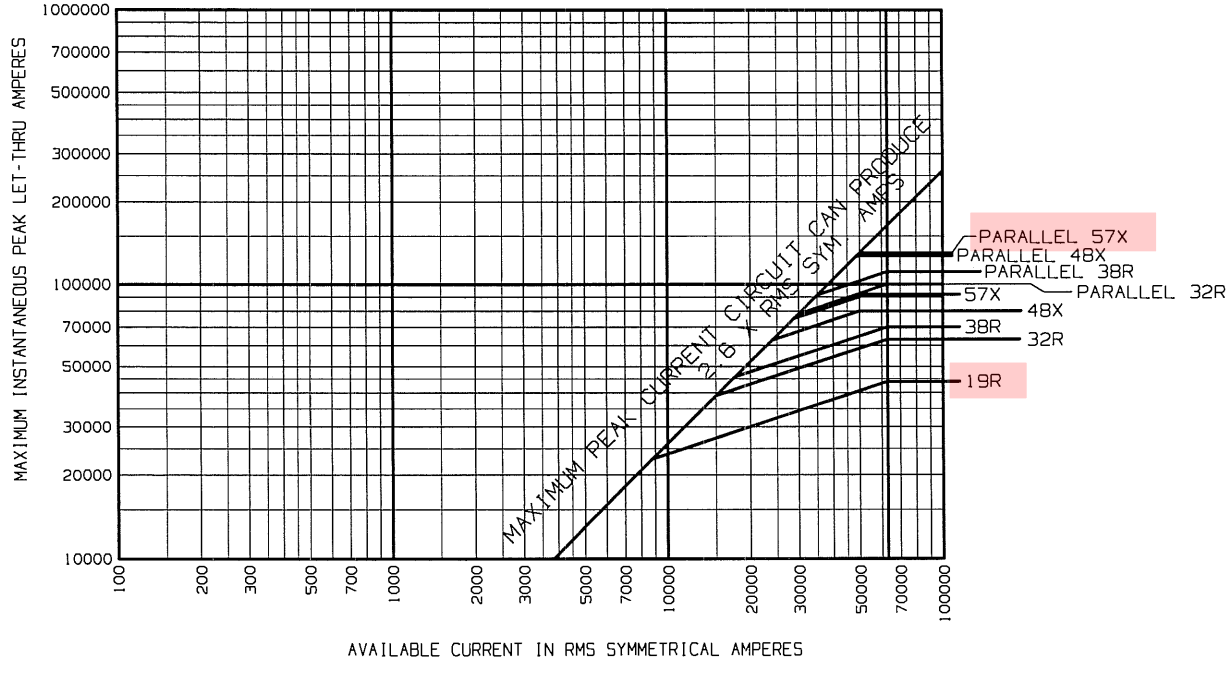
MEDIUM VOLTAGE AMP-TRAP FUSE

CAT. NO. A051B1DAR0-19R
A051B2DAR0-32R
A051B2DAR0-38R
A051B3DAR0-48X
A051B3DAR0-57X
19R - 38R 5.5KV MAX
48X & 57X 5.2KV MAX

PEAK LET-THRU DATA

FERRAZ SHAWMUT
NEWBURYPORT, MA 01950

102655



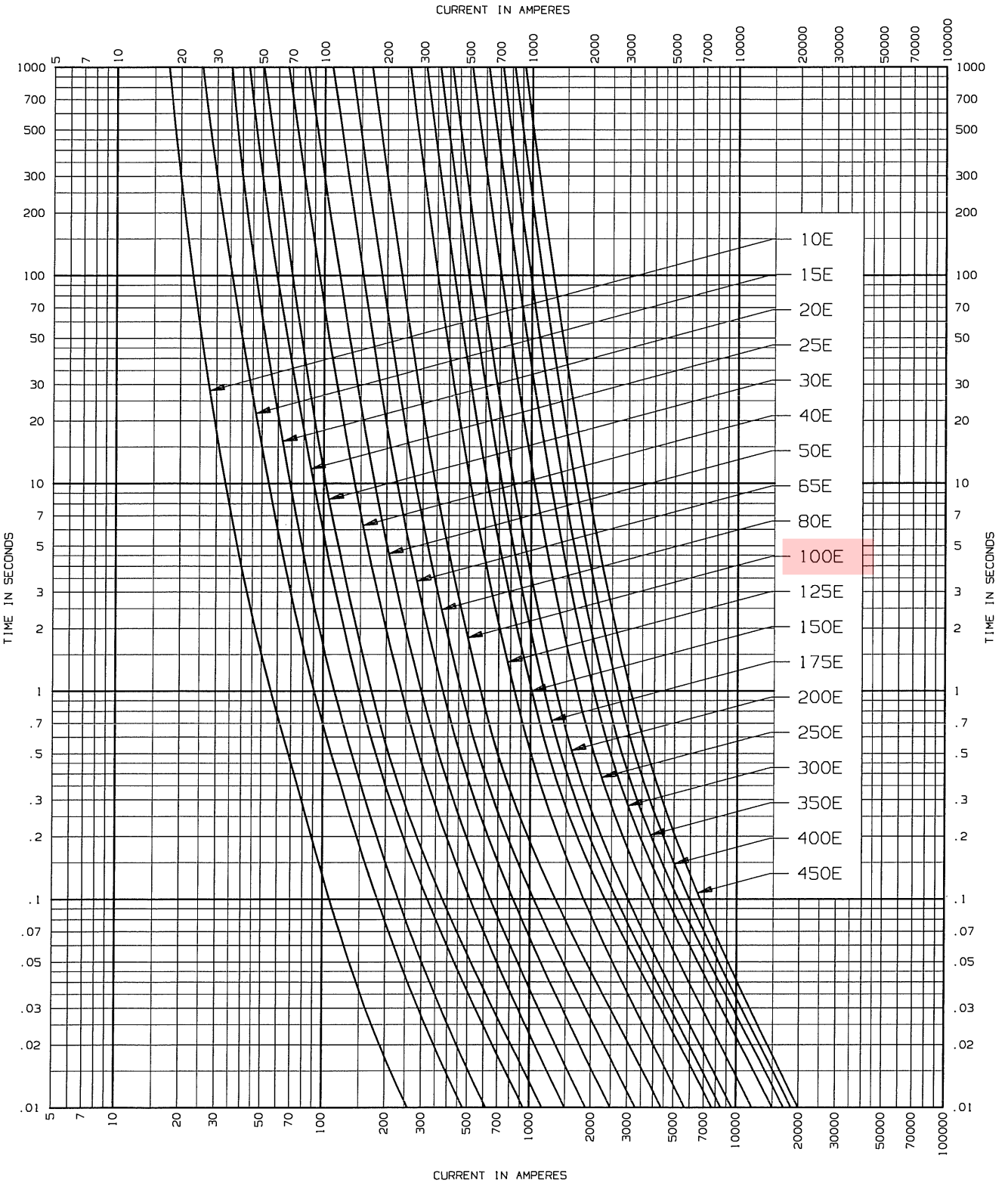
CONTROL NO: S69

REV. D
5-17-04

MEDIUM VOLTAGE AMP-TRAP FUSE
MINIMUM MELTING TIME CURRENT DATA
CS-3 5.5KV
CAT. NO. A055F1D0R0-(10E-200E)
A055F2D0R0-(250E-450E)
GOULD SHAWMUT
NEWBURYPORT, MA 01950

24443

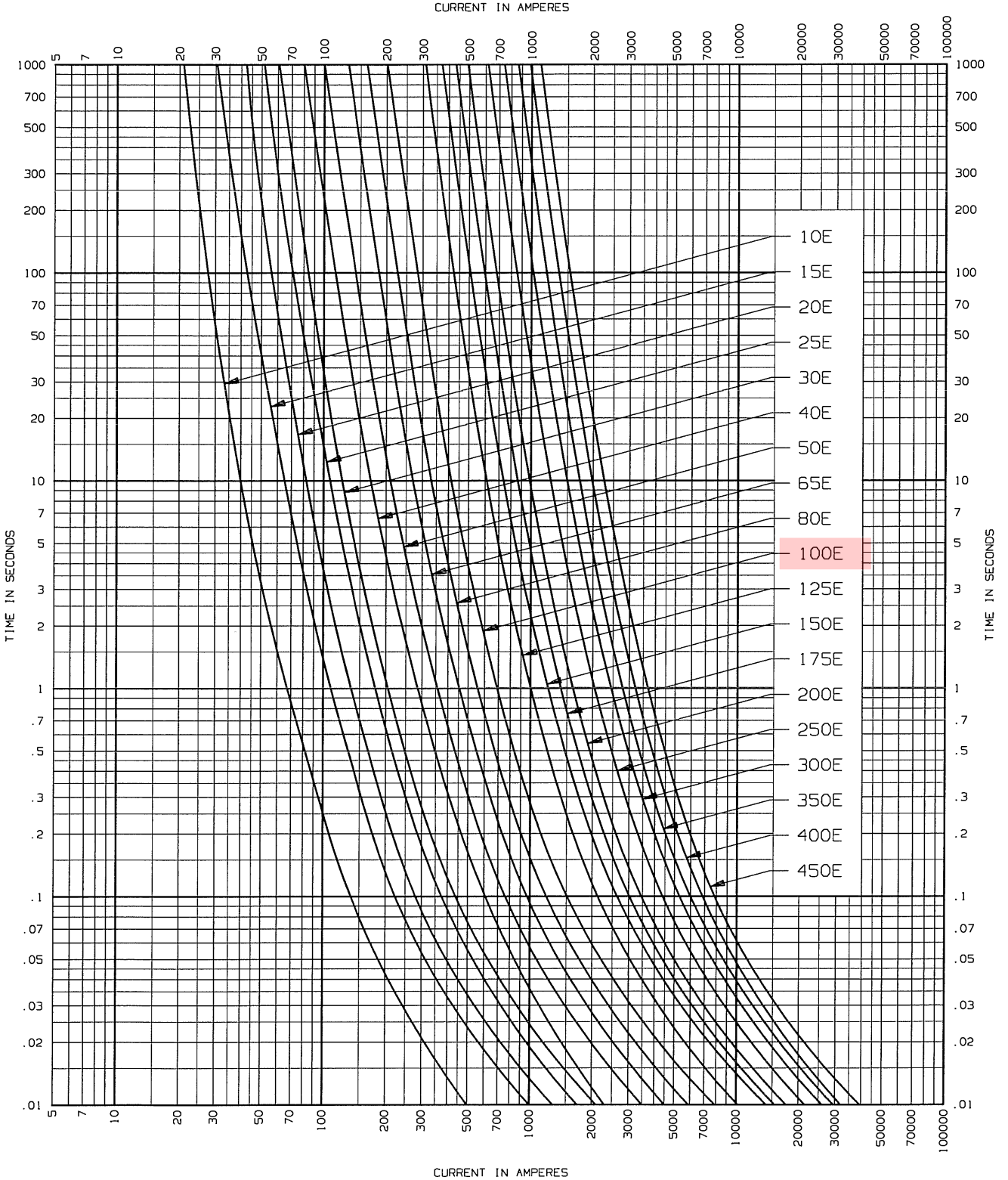
INIT REL
2APR93



MEDIUM VOLTAGE AMP-TRAP FUSE
TOTAL CLEARING TIME CURRENT DATA
CS-3 5.5KV
CAT. NO. A055F1D0R0-(10E-200E)
A055F2D0R0-(250E-450E)
GOULD SHAWMUT
NEWBURYPORT, MA 01950

24442

INIT REL
2APR93



MEDIUM VOLTAGE FUSE

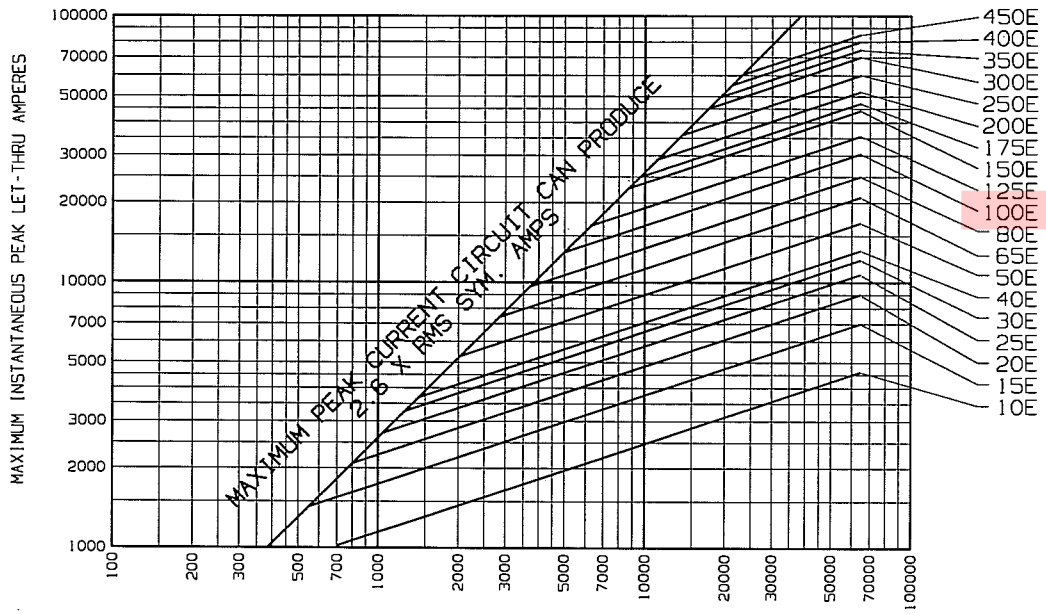
CAT. NO. A055F1D0R0-(10E-200E)
A055F2D0R0-(250E-450E)

10E-450E 5.5KV

PEAK LET THRU CURRENT DATA

FERRAZ SHAWMUT
NEWBURYPORT, MA 01950

720607



CONTROL NO.: 639
REV.: -
FOLDER NO.: 58
8/11/04

A240T/A480T/A500T/A720T POTENTIAL TRANSFORMER FUSES

POTENTIAL TRANSFORMER FUSES

Ferraz Shawmut E-rated PT fuses are current limiting fuses with high interrupting rating, used for primary winding protection of potential transformers. They are small dimension, ferrule-type fuses and mounted in standard clips. Ratings are 1/2E to 5E at 2.4, 4.8, 5.0 and 7.2kV.

Features/Benefits

- **Current limiting** protection for transformers
- **Ferrule mounting** for ease of installation in standard clips
- **Compact size** saves valuable mounting space
- **Fiberglass melamine body** provides dimensional stability in harsh industrial environments
- **Metal embossed catalog number** for lasting identification

Ratings

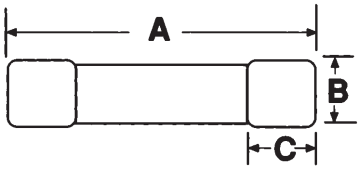
- **A240T**
  AC: 1/2E to 5E
  2400VAC, 50kA I.R. Sym.
- **A500T**
  AC: 1/2E to 5E
  5000VAC, 50kA I.R. Sym.
- **A480T**
  AC: 1/2E to 5E
  4800VAC, 50kA I.R. Sym.
- **A720T**
  AC: 1E to 2E
  7200VAC, 50kA I.R. Sym.

HIGHLIGHTS:

- E-Rated
- Current-Limiting

APPLICATIONS:

- Primary protection for 2.4, 4.8, 5.0 or 7.2kV potential transformers



Standard Fuse Ampere Ratings, Catalog Numbers

E RATING	CATALOG NUMBER			
	2400V	4800V	5000V	7200V
1/2E	A240T1/2E	A480T1/2E	A500T1/2E-1	A720T1/2E-1
1E	A240T1E	A480T1E	A500T1E-1	A720T1E-1
2E	A240T2E	A480T2E	A500T 2E-1	A720T2E-1
3E	-	A480T3E	A500T3E-1	A720T3E-1
4E	-	A480T4E	A500T 4E-1	-
5E	A240T5E	A480T5E	A500T5E-1	-

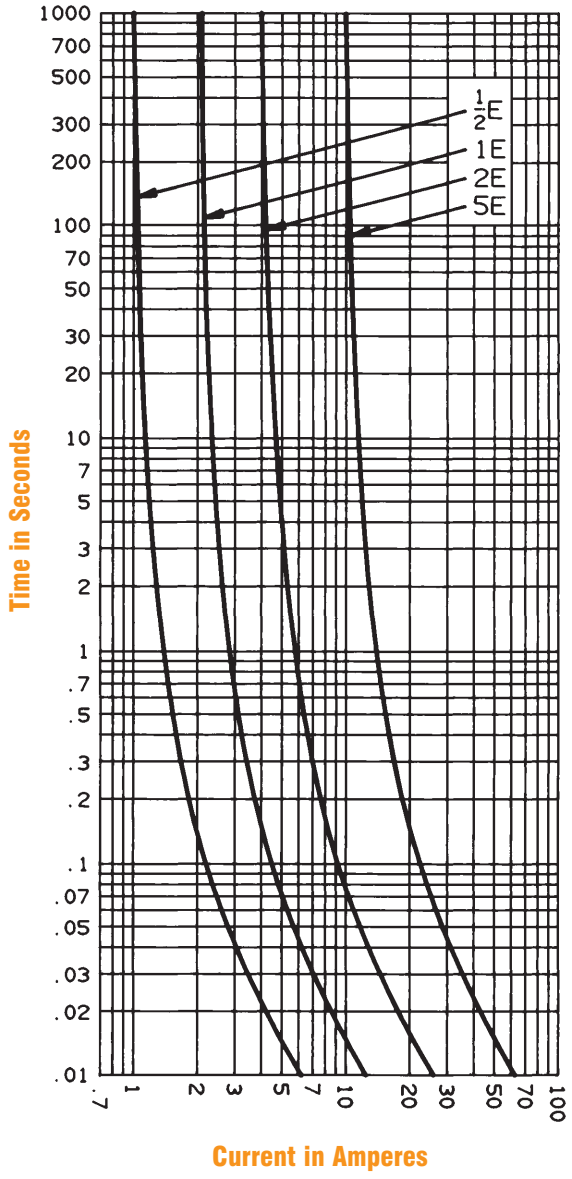
Dimensions

CATALOG NO. PREFIX	DIMENSIONS - inches			FUSE CLIPS*	
	A	B	C	CENTERS	CAT. NO.
A240T	4-5/8	13/16	5/8	4.0"	C08917P
A480T	5-5/8	13/16	5/8	5.0"	C08917P
A500T	5-5/8	1	9/16	5.0"	-
A720T	9-1/2	13/16	5/8	8.88"	C08917P

*Use 2 clips per fuse.

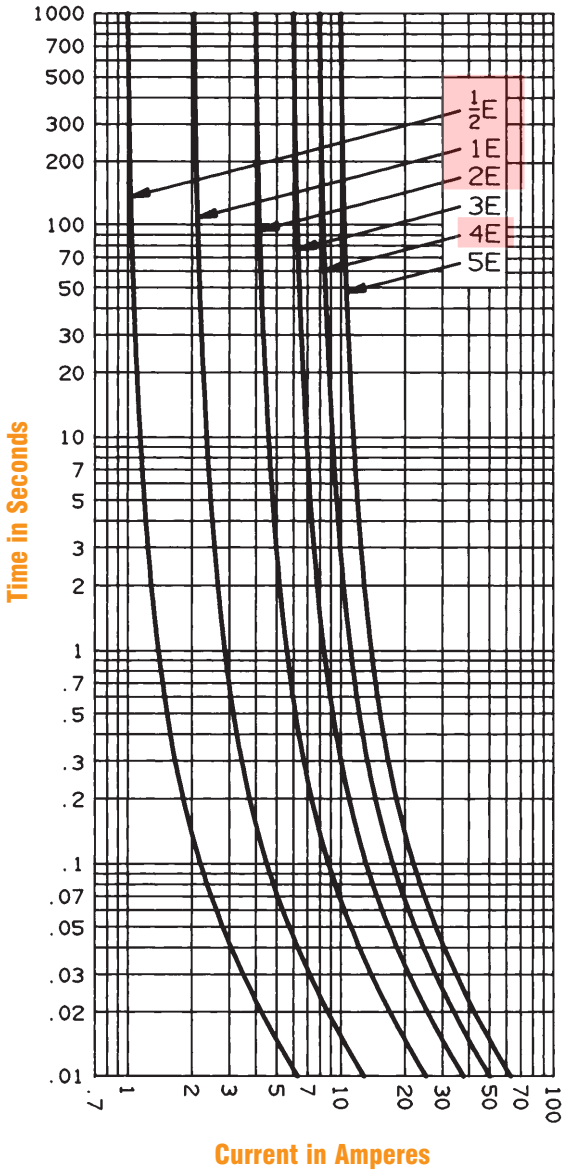
A240T1/2E to 5E

Melting Time – Current Data - PT Fuses - 2400V



A480T1/2E to 5E

Melting Time – Current Data - PT Fuses - 4800V



E

TRI-ONIC®

TRM

1-1/2" X 13/32" MIDGET FUSES

Tri-onic TRM time-delay midget fuses are rated 250 volts AC and are offered in 36 ampere ratings from 1/10A to 30A. They have 12 seconds time delay at 200% rating to provide supplemental protection of small motors, small transformers and other high inrush loads, plus many other 250 volt applications. (Not for Branch Circuit Protection).

Features/Benefits

- **Numerous ratings** for a wide variety of applications
- **250VAC rating** in all sizes up to 30A
- **Time delay** for circuits with high inrush currrent
- Can be used with **ULTRASAFE**™ fuse holders

C

HIGHLIGHTS:

- Time Delay
- 250 VAC Rated

APPLICATIONS:

- Small Motors
- Small Transformers
- Lighting Circuits
- Control Circuits

Ratings

- **AC:** 1/10 to 30A 250VAC, 10kA I.R.

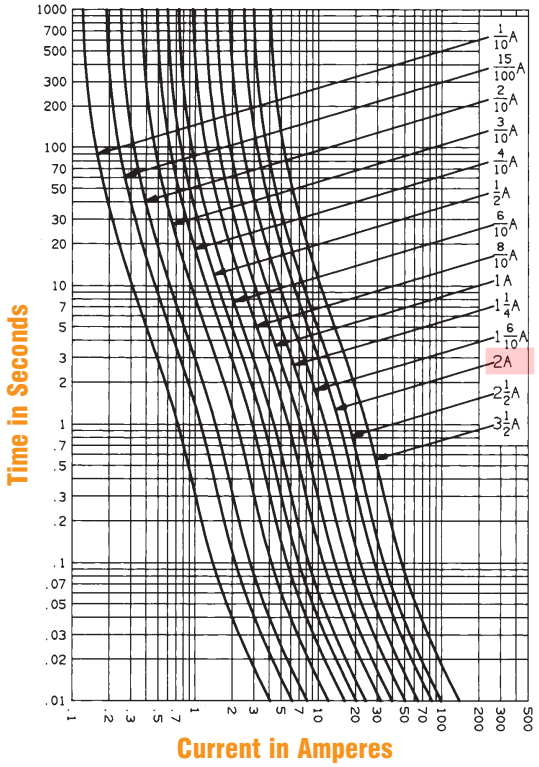
Approvals

- UL Listed to Standard 248-14
- CSA Certified to Standard C22.2 No. 248.14

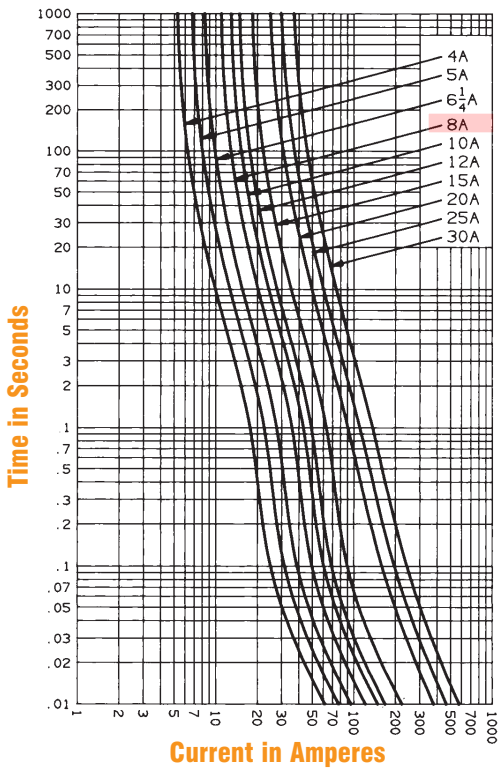
Standard Fuse Ampere Ratings, Catalog Numbers

AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER
1/10	TRM1/10	6/10	TRM6/10	1-6/10	TRM1-6/10	3	TRM3	5-6/10	TRM5-6/10	10	TRM10
15/100	TRM15/100	8/10	TRM8/10	1-8/10	TRM1-8/10	3-2/10	TRM3-2/10	6	TRM6	12	TRM12
2/10	TRM2/10	1	TRM1	2	TRM2	3-1/2	TRM3-1/2	6-1/4	TRM6-1/4	15	TRM15
3/10	TRM3/10	1-1/8	TRM1-1/8	2-1/4	TRM2-1/4	4	TRM4	7	TRM7	20	TRM20
4/10	TRM4/10	1-1/4	TRM1-1/4	2-1/2	TRM2-1/2	4-1/2	TRM4-1/2	8	TRM8	25	TRM25
1/2	TRM1/2	1-4/10	TRM1-4/10	2-8/10	TRM2-8/10	5	TRM5	9	TRM9	30	TRM30

Melting Time – Current Data 1/10 - 3-1/2 Amperes, 250 Volts AC



Melting Time – Current Data 4 - 30 Amperes, 250 Volts AC



AMP-TRAP®

ATM

1-1/2" X 13/32" MIDGET FUSES

Amp-trap midget fast-acting ATM fuses are rated 600 volts AC, with a 100kA interrupting rating. These ratings give the ATM a wide range of applications not covered by other midget fuses. In addition, ratings of 30/35, 30/40 and 30/50 amperes are offered for specific applications such as capacitor protection. These ATM fuses must still be considered 30A fuses because of their dimensions, but are able to withstand much higher inrush currents and tougher duty cycles. (Not for Branch Circuit Protection).

Features/Benefits

- **For supplemental protection** of small motors and transformers
- **Extended ratings** for special protection of capacitors and circuits with high inrush currents
- **500VDC ratings** for a wide variety of applications
- Can be used with **ULTRASAFE**™ fuse holders

HIGHLIGHTS:

- Fast Acting
- Special Ratings (above 30A)

APPLICATIONS:

- Supplemental protection of a wide variety of circuits up to 600VAC and 500VDC with 100kA I.R.

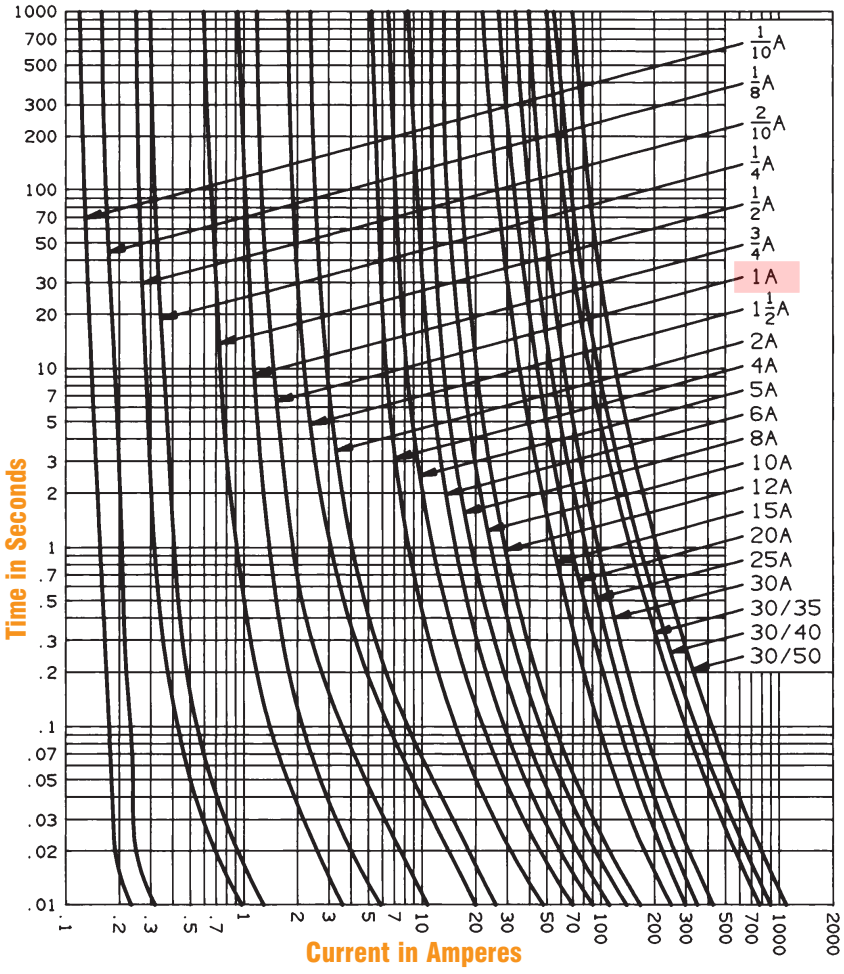
Ratings

- **AC:** 1/10 to 30A 600VAC, 100kA I.R.; 35 to 50A 600VAC, 10kA I.R.
- **DC:** 1/10 to 30A 500VDC, 100kA I.R.

Approvals

- UL Listed to Standard 248-14 (1/10 to 30A)
- DC listed to UL Standard 198L (1/10 to 30A)
- CSA Certified to Standard C22.2 No. 248.14 (1/10 to 30A)

Melting Time – Current Data 1/10 - 30/50 Amperes, 600 Volts AC



Standard Fuse Ampere Ratings, Catalog Numbers

AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER
1/10	ATM1/10	6	ATM6
1/8	ATM1/8	8	ATM8
2/10	ATM2/10	10	ATM10
1/4	ATM1/4	12	ATM12
1/2	ATM1/2	15	ATM15
3/4	ATM3/4	20	ATM20
1	ATM1	25	ATM25
1-1/2	ATM1-1/2	30	ATM30
2	ATM2	30/35	ATM30/35*
3	ATM3	30/40	ATM30/40*
4	ATM4	30/50	ATM30/50*
5	ATM5		

* are not continuous current rated devises

ALLEN-BRADLEY NAMEPLATE FURNISHED BY SUPPLIER.
NAMEPLATE TO BE STAMPED BY SUPPLIER AS DIRECTED AND MOUNTED ON THE TOP OF THE TRANSFORMER TO READ FROM THE PRIMARY SIDE.

A-B NAMEPLATE REFERENCE: 80006-353-01
STAMP NAMEPLATE WITH:
PART NUMBER
PRIMARY AND SECONDARY VOLTAGES
HERTZ AND KVA AS SHOWN
MANUFACTURED DATE

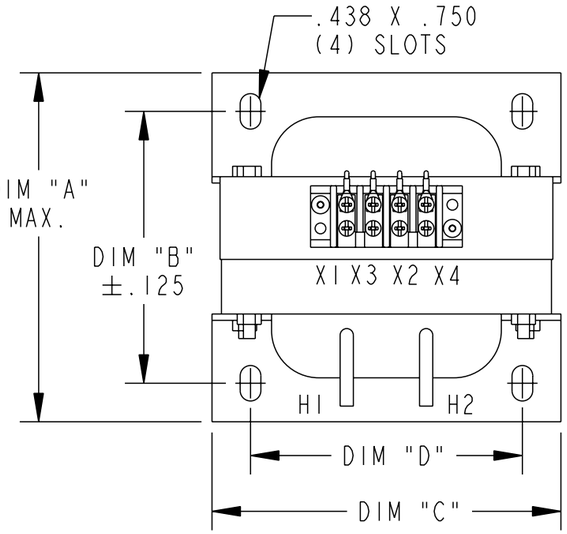
ALL PARTS MUST BE CAPABLE OF MEETING THE REQUIREMENTS SPECIFIED HEREIN:
1.1 INSULATION AND TEMPERATURE RISE: CLASS F, 115°C RISE.
1.2 TRANFORMERS MUST MEET BASIC IMPULSE INSULATION LEVEL (BIL) AS INDICATED BELOW.
1.3 TRANSFORMERS MUST MEET DIELECTRIC WITHSTAND VOLTAGE AS INDICATED BELOW, FOR 1 SECOND. (TEST TO BE REPEATED AT ROCKWELL AUTOMATION)
1.4 RATED FREQUENCY: 50/60Hz.
1.5 SECONDARY WINDINGS TO PROVIDE VOLTAGE SHOWN ON TABLE BELOW AT RATED PRIMARY VOLTAGE.
1.6 TRANSFORMERS MUST DELIVER RATED VA CONTINOUSLY AT RATED PRIMARY VOLTAGE AT 50 AND 60 Hz WITHOUT EXCEEDING RATED TEMPERATURE RISE.

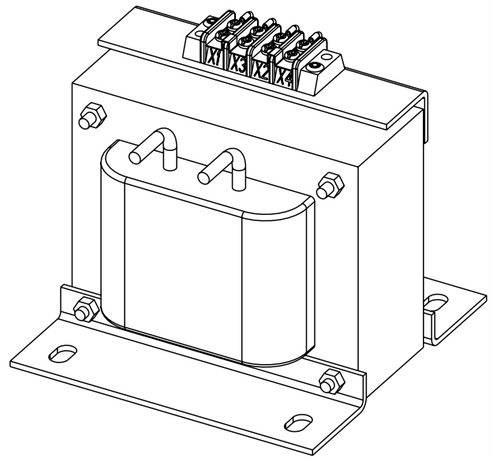
WIRE LEADS AND MARKINGS:
2.1 HIGH VOLTAGE "H" LEADS ARE #14 AWG AND 3.50 FEET LONG.
2.2 LEAD WIRE TO BE 15KV, 105°C, UL LISTED, PAIGE ELECTRIC TUF-HIDE GTO-15 OR EQUIVALENT.
2.3 WIRE MARKINGS REQUIRED ON "H1" AND "H2" QTY (2) PER LEAD. THE FIRST MARKING APPROXIMATELY 0.50 INCHES FROM THE CORE AND THE SECOND MARKING APRROXIMATELY 24.00" FROM THE CORE.
2.4 SECONDARY "X" LEADS TO BE MOUNTED ON TERMINAL BLOCK.

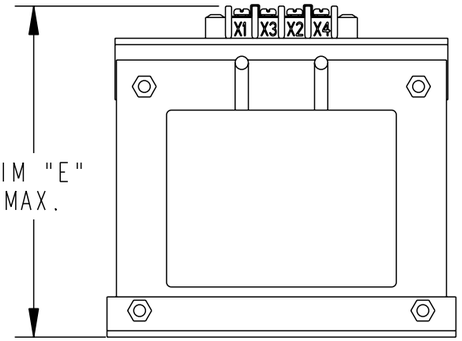
7200 PRIMARY RATED CPT:
3.1 PART -05 IS RATED FOR THE FOLLOWING VOLTAGES:
7200 PRIMARY 120/240 SECONDARY
6900 PRIMARY 115/230 SECONDARY
6600 PRIMARY 110/220 SECONDARY

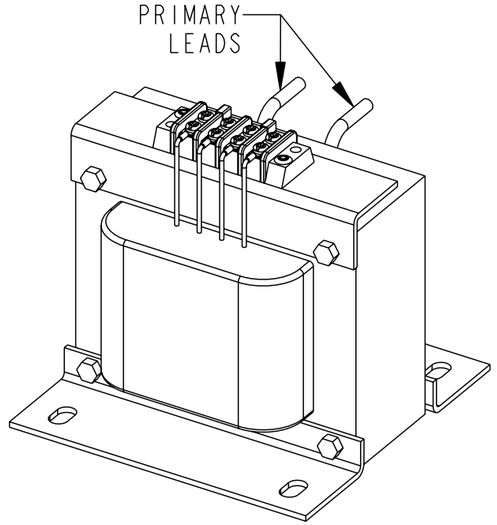
VENDOR MODIFICATIONS AND RESPONSIBILITIES
ROCKWELL AUTOMATION ENGINEERING SHALL BE NOTIFIED IMMEDIATELY OF ANY PROPOSED CHANGES IN MATERIALS OR PROCESSES WHICH COULD AFFECT THE PERFORMANCE, RELIABILITY OR PHYSICAL CHARACTERISTICS OF THIS DEVICE.
NO SHIPMENT SHALL BE MADE WITHOUT PRIOR APPROVAL FROM ROCKWELL AUTOMATION ENGINEERING.

NO CLASSIFIED CHARACTERISTICS









PART No.	CHG. CHAR.	PRIMARY VOLTAGE	SECONDARY VOLTAGE	REFER TO NOTE	DIM "A" MAX.	DIM "B" ±.125	DIM "C"	DIM "D"	DIM "E" MAX.	BIL	DIELECTRIC WITHSTAND VOLTAGE (60 Hz)
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-06	1	4800	120/240	N/A	7.38	5.75	6.75	5.75	7.00	25KV	16000
-05	1	7200	120/240	3.1	7.50	5.75	9.00	8.00	9.63	35KV	22000
-04	1	6000	115/230	N/A	7.50	5.75	9.00	8.00	9.63	35KV	22000
-03	1	4200	115/230	N/A	7.38	5.75	6.75	5.75	7.00	25KV	16000
-02	1	3300	110/220	N/A	7.38	5.75	6.75	5.75	7.00	25KV	16000
-01	1	2400	115/230	N/A	7.38	5.75	6.75	5.75	7.00	25KV	16000

USER ID: DRANDALL
ECN NUMBER: C-1128-11
REV. NO.: 3

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGLES ±1°
2 DECIMAL (X.XX) ±.03
3 DECIMAL (X.XXX) ±.010
BEND RADIUS - ALLOWANCE -

Rockwell Automation

BULLETIN 1500 | SIZE - | TYPE EEMAC/NEMA -
PURCHASED COMPONENT
TRANSFORMER
MEDIUM VOLTAGE
-
-
-
1KVA CPT 2400 TO 7200 VOLT
DUAL VOLTAGE CPT'S

REF. 25638-510/-511 -
A-B ORDER NO. -

Allen-Bradley

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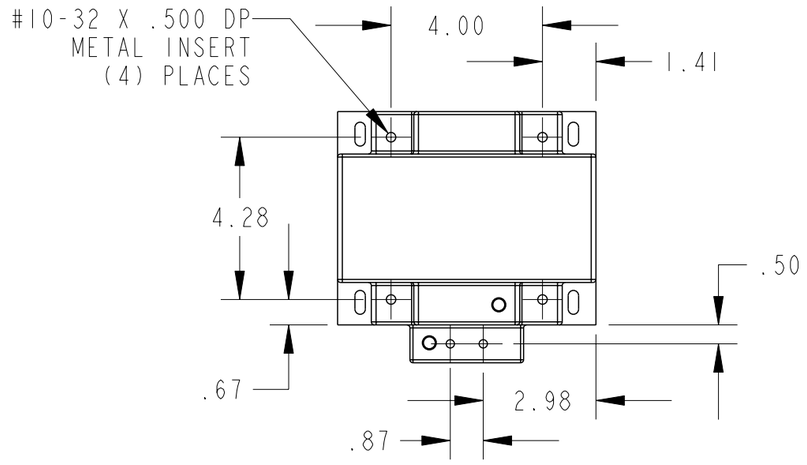
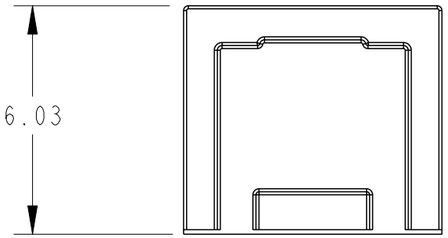
DR. PAUL VAN HEESWYK | DATE 2006-04-22
CHKD. | DATE

SHEET 1 OF 1
DWG. NO. 80022-154

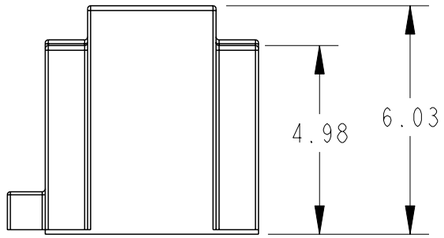
MVBBH05

Pro/ENGINEER®

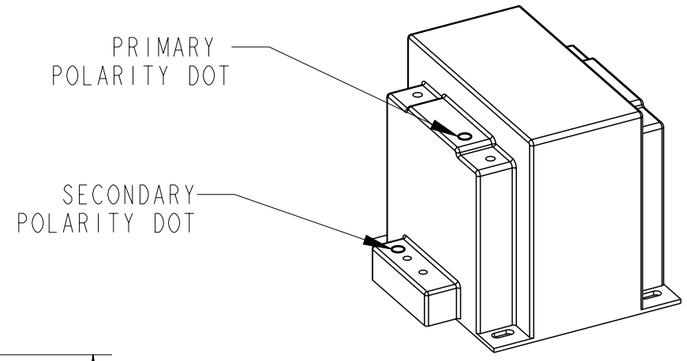


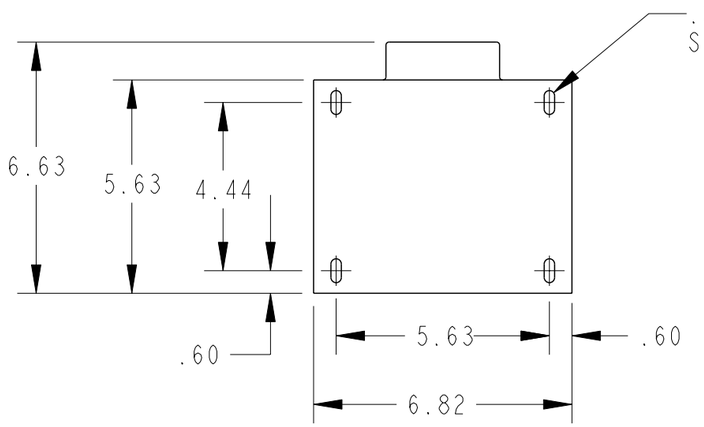


POLARITY DOT



NOTE: FUSES AND CLIPS ARE CALLED UP ON HIGHER ASSEMBLY





VENDOR MOIFICATIONS AND RESPONSIBILITES

ROCKWELL AUTOMATION ALLEN-BRADLEY ENGINEERING SHALL BE NOTIFIED IMMEDIATELY OF ANY PROPOSED CHANGES IN MATERIALS OR PROCESSES WHICH COULD AFFECT THE PERFORMANCE, RELIABILITY, OR PHYSICAL CHARACTERISTICS OF THE DEVICE.
NO SHIPMENT SHALL BE MADE WITHOUT PRIOR APPROVAL FROM ALLEN-BRADLEY ENGINEERING.

PART NO.	CHG. CHAR.	THERMAL RATING 30°C/55°C	GE-ITI PART NO.	ACCURACY	VOLTAGE RATIO
-04	2	600VA / 425VA	PT3-2-45-482SSRE	0.3X	4800-120 60Hz
-03	2	600VA / 425VA	PT3-2-45-422SSRE	0.3X	4200-120 60Hz
-02	2	600VA / 425VA	PT3-2-45-332SSRE	0.3X	3300-110 50Hz
-01	2	600VA / 425VA	PT3-2-45-242SSRE	0.3X	2400-120 60Hz

USER ID: PBREWER
ECN NUMBER: C-2168-05
REV. NO.: 3

DIMENSIONS IN DIMUNIT
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGLES ±1°
2 DECIMAL (X.XX) ±.03
3 DECIMAL (X.XXX) ±.010
BEND RADIUS - ALLOWANCE -

Rockwell Automation

BULLETIN	SIZE	TYPE EEMAC/NEMA
-	-	-

PART
POTENTIAL TRANSFORMER
MEDIUM VOLTAGE
-
-
-
5Kv GE ITI PT3 POTENTIAL TRANSFORMER
-

REF. -
A-B ORDER NO. -

Allen-Bradley

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DR. PAUL BREWER
DATE 2005-06-01
CHKD.
DATE

SHEET 1 OF 1
DWG. NO. 80022-164

MVBBH05

Pro/ENGINEER®

GENERAL NOTES:

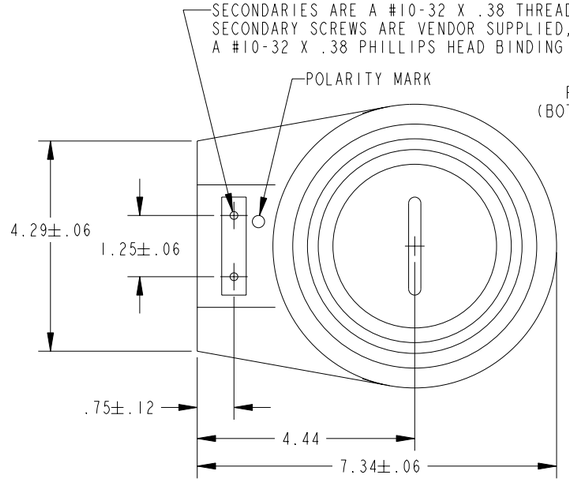
1) UNITS MUST PASS 18.5KV 60 Hz (1) MINUTE OR 22KV 60 Hz (1) SECOND DIELECTRIC TEST BETWEEN PRIMARY TERMINALS AND A GROUNDED PLATE AT SURFACE "A", WITH THE SECONDARY WINDING GROUNDED.
2) UNITS ARE SUITABLE FOR APPLICATIONS TO 7200VAC LINE TO LINE.
3) UNITS TO MEET PARTIAL DISCHARGE PER STANDARD CAN3-C13-M83.
4) UNITS MUST PASS 60kV BIL BETWEEN PRIMARY TERMINALS AND GROUNDED PLATE AT SURFACE "A" WITH SECONDARY WINDING GROUNDED.
5) UNITS MUST BE CSA / UL LABELED.
6) AMRAN DWG. N-301-2

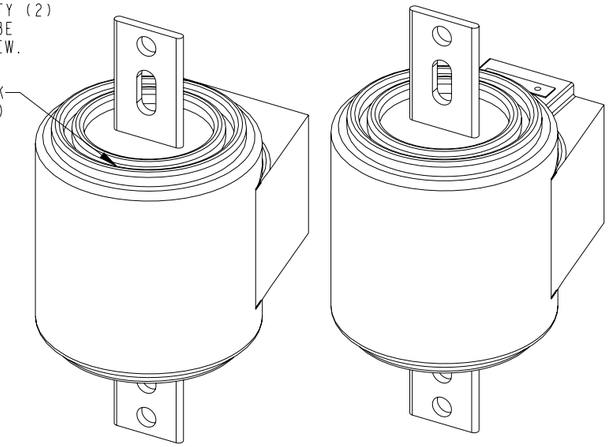
VENDOR MODIFICATIONS AND RESPONSIBILITIES:
ROCKWELL AUTOMATION CANADA INC. ENGINEERING SHALL BE NOTIFIED IMMEDIATELY OF ANY PROPOSED CHANGES IN MATERIALS OR PROCESSES WHICH COULD AFFECT THE PERFORMANCE, RELIABILITY, OR PHYSICAL CHARACTERISTICS OF THIS DEVICE. NO SHIPMENT SHALL BE MADE WITHOUT PRIOR APPROVAL FROM ROCKWELL AUTOMATION ENGINEERING.

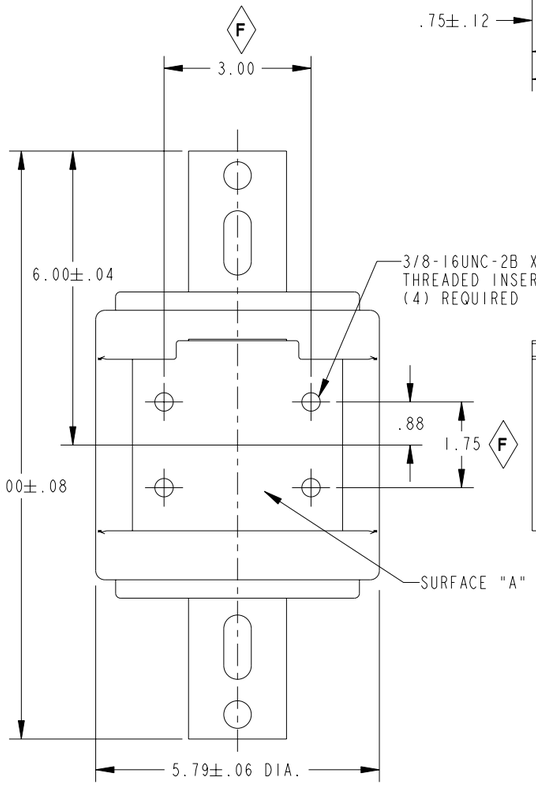
-	-	-	-	-
3.25	F-6	-	X	-
3.25	D-6	-	X	-
1.75	E-4	-	X	-
3.00	C-3	-	X	-
DIELECTRIC TEST (NOTE 1)	A-1	X	-	-
IMPULSE TEST (NOTE 4)	H-4	X	-	-
ACCURACY	H-3	X	-	-
CHARACTERISTIC -OR- DIMENSION	DRAWING LOCATION (ZONE)	P	F	A
CLASSIFICATION TABLE				
P=PERFORMANCE, F=FIT, A=ASSEMBLY				

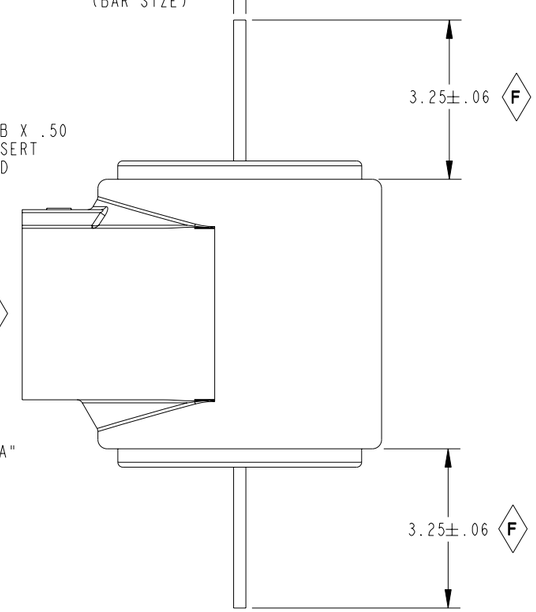
LABEL NOTES :

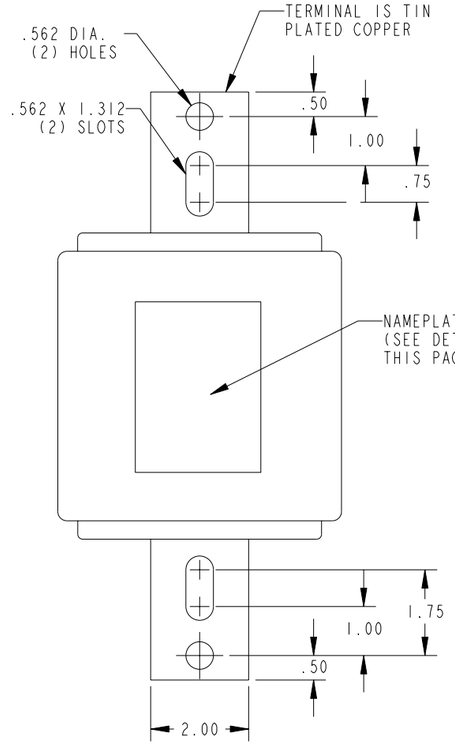
(1) - CSA / UL MARKING
(2) - AB PART NO.
(3) - DATE CODE
(4) - RATIO











Allen-Bradley

CURRENT TRANSFORMER

(4) 7200V 50/60 Hz 60kV BIL
PART NO: (2)
TRF: 1.0 @ 60°C AMBIENT
MFG DATE: (3) (1)
SR. NO. MADE IN INDIA

NAMEPLATE DETAIL
(SEE NOTE @ D-1)

PART NO.	CHG. LTR.	RATIO	AMRAN PART No.	PEAK DYNAMIC SHORT TIME RATING	SHORT TIME THERMAL CURRENT RATING I-SEC. (AMPS RMS SYMMETRICAL)	METERING ACCURACY AT 50 AND 60 Hz (P)				RELAY CLASS AT 60 Hz	RELAY CLASS AT 50 Hz	CONTINUOUS THERMAL CURRENT RATING FACTOR	IMPULSE LEVEL FULL WAVE (P)	FREQUENCY	BAR SIZE
						B0.1	B0.5	B0.9	B1.8	10C	10C				
-12	3	3000:5	C10.4-60-302	144000	100000	0.3	0.3	0.3	0.3	200	100	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	(2).50X2.0
-11	3	2500:5	C10.4-60-252	144000	100000	0.3	0.3	0.3	0.3	200	120	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	(2).50X2.0
-10	3	2000:5	C10.3-60-202	144000	100000	0.3	0.3	0.3	0.3	200	125	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	(2).38X2.0
-09	3	1500:5	C10.2-60-152	144000	90000	0.3	0.3	0.3	0.3	150	125	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.50 X 2.0
-08	3	1200:5	C10.2-60-122	144000	70000	0.3	0.3	0.3	0.3	150	115	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.38 X 2.0
-07	3	1000:5	C10.2-60-102	144000	70000	0.3	0.3	0.3	0.3	125	95	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.38 X 2.0
-06	3	800:5	C10.2-60-801	144000	70000	0.3	0.3	0.3	0.3	100	75	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.38 X 2.0
-05	3	600:5	C10.2-60-601	144000	70000	0.3	0.3	0.3	0.3	80	65	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.38 X 2.0
-04	3	500:5	C10.2-60-501	144000	55000	0.3	0.3	0.3	0.6	80	65	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.25 X 2.0
-03	3	400:5	C10.2-60-401	144000	55000	0.3	0.3	0.3	0.6	80	60	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.25 X 2.0
-02	3	300:5	C10.2-60-301	126000	50000	0.3	0.3	0.6	1.2	65	50	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.25 X 2.0
-01	3	200:5	C10.2-60-201	126000	50000	0.3	0.6	1.2	2.4	40	35	1.0 @ 60°C AMBIENT	60 KV	50/60 Hz	.25 X 2.0

USER ID	AWANG4
ECN NUMBER	C-2048-10
REV. NO.	6
DIMENSIONS IN INCHES	
TOLERANCES UNLESS OTHERWISE SPECIFIED	
ANGLES ± 1°	
2 DECIMAL (X.XX) ±.03	
3 DECIMAL (X.XXX) ±.010	
BEND RADIUS - ALLOWANCE -	
BULLETIN	1500
SIZE	-
TYPE	EEMAC/NEMA -
EQUIPMENT	CURRENT TRANSFORMER
	MEDIUM VOLTAGE
	-
	-
	-
	AMRAN BAR-TYPE TRANSFORMER
	-
REF.	80022-160 80025-160
A-B ORDER NO.	-

Rockwell Automation

Allen-Bradley

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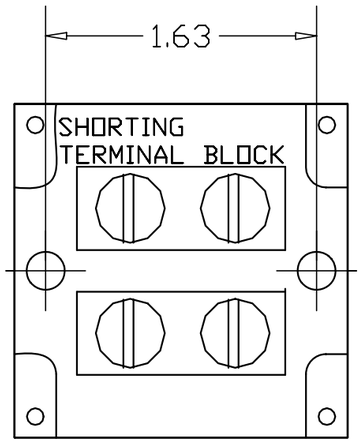
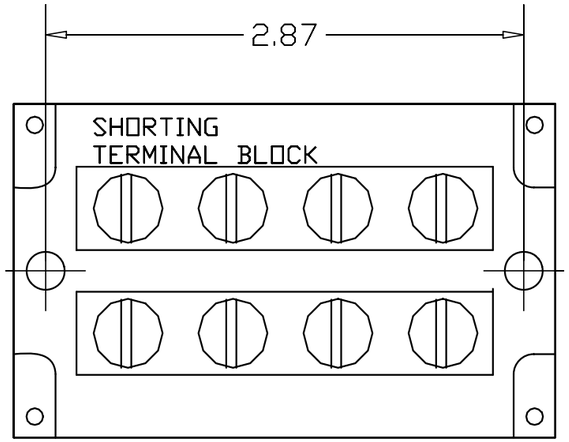
DR. PAUL BREWER	DATE 2006-03-15
CHKD.	DATE
SHEET 1 OF 3	DWG. NO. 80022-188

MVBCH05

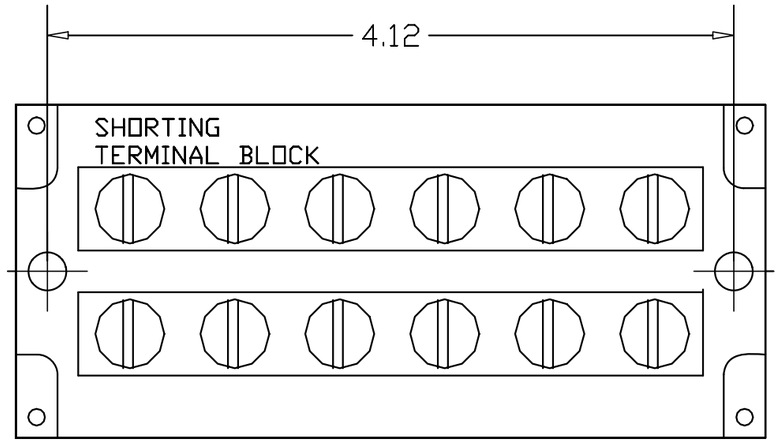
Pro/ENGINEER®



80025-211-03



80025-211-01



80025-211-02

NOTE:
-01 G.E. # EB27B04S
OR EQUIVALENT

-02 G.E. # EB27B06S
OR EQUIVALENT

-03 G.E. # EB27B02S
OR EQUIVALENT

NO CLASSIFIED CHARACTERISTICS

PART NO.	CHG. LTR.	MATERIAL	FINISH
-03	2	SEE NOTE ABOVE	NONE
-02	2	SEE NOTE ABOVE	NONE
-01	2	SEE NOTE ABOVE	NONE

USER ID: PBREWER
ECN NUMBER: C-1077-04
REV. NO.: 6

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGLES ±1°
2 DECIMAL (XX) ±.03
3 DECIMAL (XXX) ±.010
BEND RADIUS 0.06 ALLOWANCE

Rockwell Automation

BULLETIN 1500 | SIZE | TYPE EEMAC/NEMA

PART
PURCHASED PART
MEDIUM VOLTAGE

SHORTING TERMINAL BLOCK

REF.
A-B ORDER NO.

Allen-Bradley

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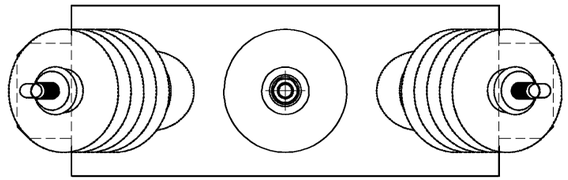
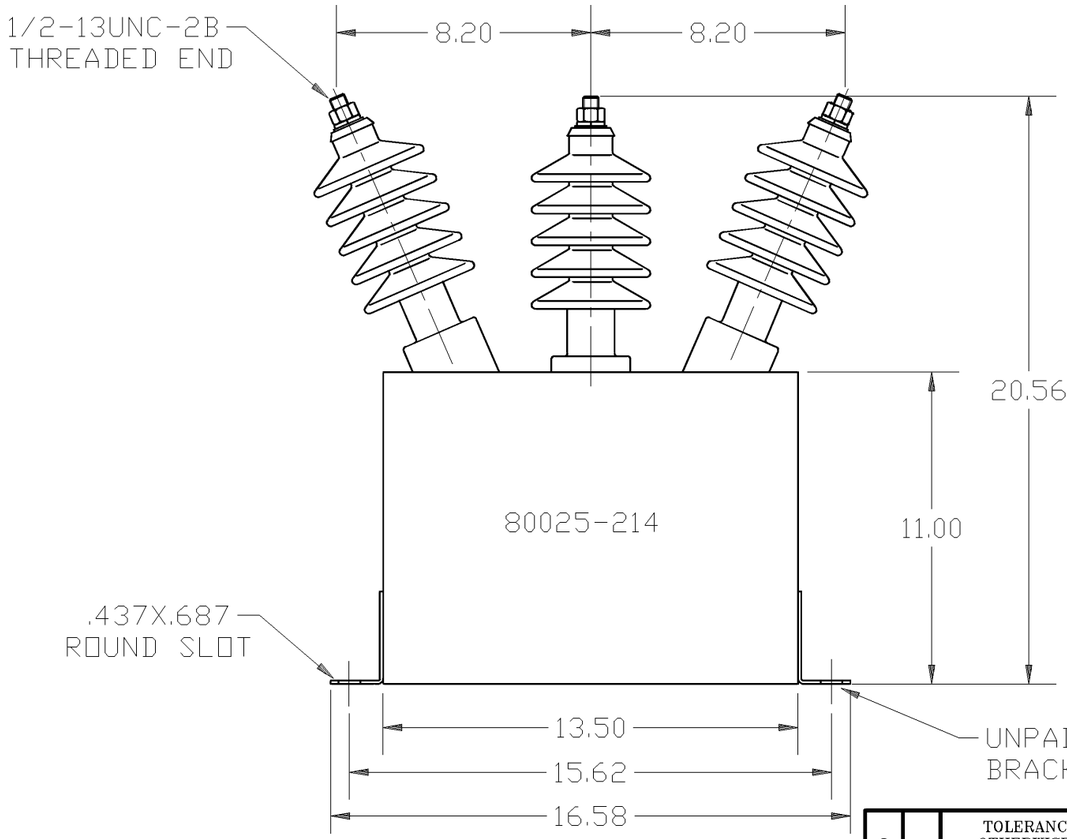
DR. BILL L | DATE 940404
CHKD. | DATE

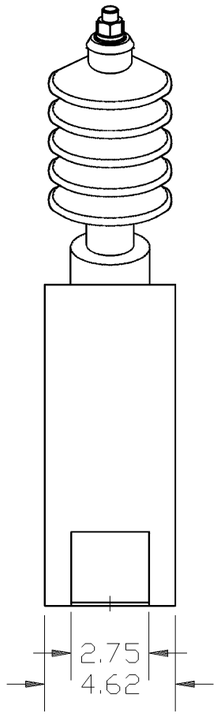
SHEET 1 OF 1
DWG. NO. 80025-211

MVBBH03

AutoCAD®







NO CLASSIFIED CHARACTERISTICS

CAPACITOR NET WEIGHT 35 LBS.

-01	F	CAT. NO. 18L0065WH	NONE
PART NO.	CHG. LTR.	MATERIAL	FINISH

USER ID: TMASON
ECN NUMBER: C-1707-03
REV. NO.: 8

TOLERANCES UNLESS OTHERWISE SPECIFIED (DIMENSIONS IN INCHES)
BEND RADIUS ALLOWANCE
ANGLES ±1°
2 DECIMAL (XX) ±.03
3 DECIMAL (XXX) ±010

BULLETIN 1500 | SIZE | TYPE EEMAC/NEMA

PART
SURGE CAPACITOR
MEDIUM VOLTAGE
7200V 3 PHASE
GE

REF.
A-B ORDER NO.

Rockwell Automation
Allen-Bradley
Medium Voltage Business

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DR. MAGGIE | DATE 910627
CHKD. | DATE

SHEET 1 OF 1
DWG. NO. 80025-214

MVBBH02

AutoCAD®

IT.	PART NO.	DESCRIPTION	AMOUNT
1	255222R2-T204	S & C 600A SWITCH , HANDLE & INTERLOCK	1
	255222R2-W-T204	S & C 600A SWITCH C/W AUXILIARY	1
	255522R2-T204	S & C 600A SWITCH, HANDLE & INTERLOCK	1
	255522R2-W-T204	S & C 600A SWITCH C/W AUXILIARY	1

ASS'Y NO.	CHG. LTR.	SUB-TITLE
-01	4	MAIN TOP ENTRY / FEEDER BOTTOM EXIT
-02	4	MAIN BOTTOM ENTRY / FEEDER TOP EXIT
-03	1	MAIN TOP ENTRY / FEEDER BOTTOM EXIT C/W AUX.
-04	1	MAIN BOTTOM ENTRY / FEEDER TOP EXIT C/W AUX.

REV.	ECN NUMBER	USER ID
6	C-1559-03	PBREWER

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BULLETIN
1592/1594

REFERENCE
-

RA ORDER NO.
-

BILL OF MATERIAL

PURCHASED COMPONENT

MEDIUM VOLTAGE

-

LOADBREAK

-

S & C 600A MINI-RUPTER LBS

C/W OPERATING HANDLE & INTERLOCK

Allen-Bradley

DR.	PAUL BREWER	DATE	2002-03-19
CHKD.		DATE	

SHEET 1 OF 1

Rockwell Automation

DWG. NO.

80025-420

Excel

7-8	-	-	X
5-6	X	-	-
3-4	-	-	X
1-2	X	-	-
CONTACT	NORMAL	OFF	TEST
	POSITION		

REPAIR PARTS REFERENCE:

CONTROL KNOB: 80025-618-01

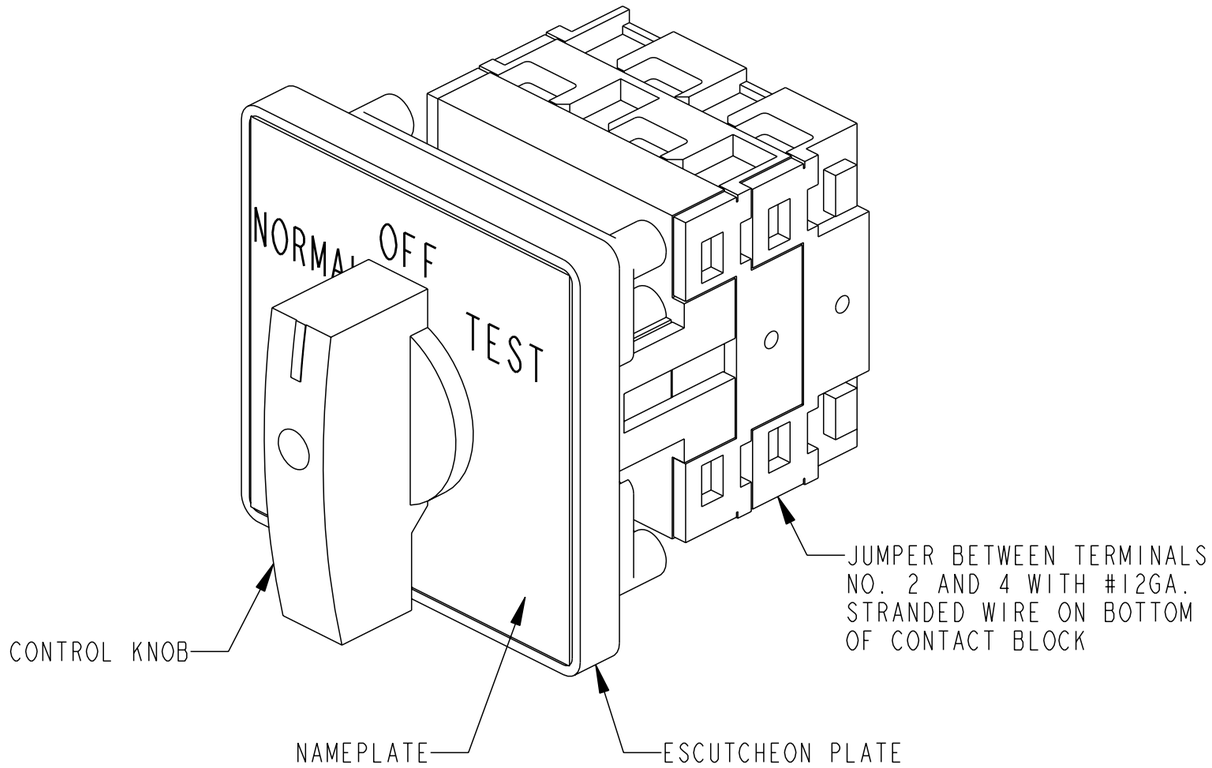
NAMEPLATE: 80025-626-01 - ENGLISH
80025-626-02 - FRENCH
80025-626-03 - BLANK
80025-626-04 - SPANISH
80025-626-05 - GERMAN
80025-626-06 - RUSSIAN
80025-626-07 - PORTUGESE
80025-626-08 - INDONESIAN
80025-626-09 - ITALIAN
80025-626-10 - POLISH

ESCUTCHEON PLATE: 80025-627-01

SWITCH BODY: 80025-628-01

JUMPER: NO PART NUMBER
(SUPPLIED BY SPRECHER AND SCHUH)

COVER PUNCHING REFERENCE: 80027-197



PART NO.	CHG. CHAR.	CATALOG NUMBER	
-10	A	S + S LE2-25 SCHEMA 10354 CHI - POLISH	
-09	A	S + S LE2-25 SCHEMA 10354 CHI - ITALIAN	
-08	A	S + S LE2-25 SCHEMA 10354 CHI - INDONESIAN	
-07	A	S + S LE2-25 SCHEMA 10354 CHI - PORTUGUESE	
-06	A	S + S LE2-25 SCHEMA 10354 CHI - RUSSIAN	
-05	A	S + S LE2-25 SCHEMA 10354 CHI - GERMAN	
-04	A	S + S LE2-25 SCHEMA 10354 CHI - SPANISH	
-03	A	S + S LE2-25 SCHEMA 10354 CHI - BLANK	OBSOLETE
-02	A	S + S LE2-25 SCHEMA 10354 CHI - BILINGUAL	
-01	A	S + S LE2-25 SCHEMA 10354 CHI - ENGLISH	

USER ID: DRANDALL
ECN NUMBER: C-1726-09
REV. NO.: 10

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGLES ±1°
2 DECIMAL (X.XX) ±.03
3 DECIMAL (X.XXX) ±.010
BEND RADIUS - ALLOWANCE -

Rockwell Automation

BULLETIN 1500 | SIZE - | TYPE EEMAC/NEMA -

ASSEMBLY
PURCHASED COMPONENT
MEDIUM VOLTAGE
-
-
-
SPRECHER AND SCHUH COMPLETE TEST SWITCH 25 AMP
-

REF. - -
A-B ORDER NO. -

Allen-Bradley
QUALITY

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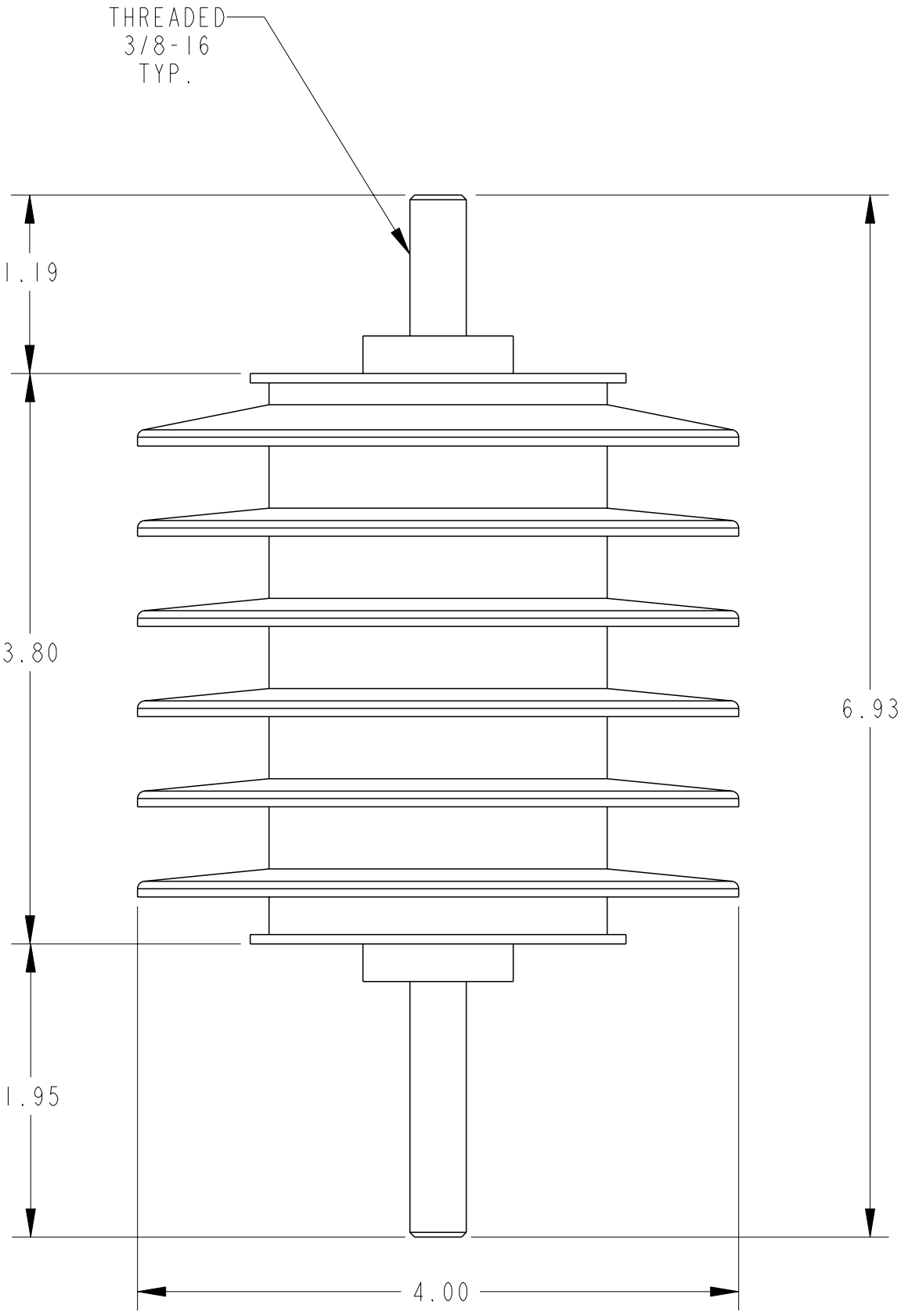
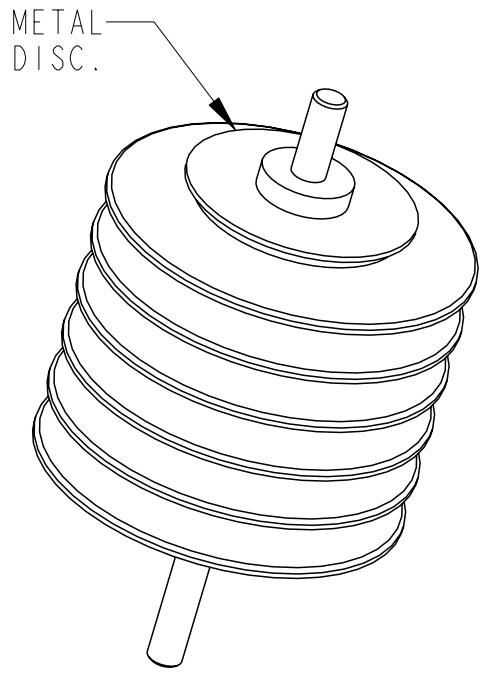
DR. PAUL VAN HEESWYK | DATE 1996-08-27
CHKD. | DATE

SHEET 1 OF 1
DWG. NO. 80025-597

MVBBH05

Pro/ENGINEER®





3 PHASE
LIGHTENING ARRESTOR.
3KV AND 6 KV.

-02 SHOWN

NOTE:

1. UNDIMENSIONED DETAILS ARE FOR REFERENCE ONLY.

PART NO.	CHG. CHAR.	MATERIAL	FINISH
-02	2	9L20FXX006XHS	NONE
-01	2	9L20FXX003XHS	NONE

USER ID	LPEART	DIMENSIONS IN INCHES	BULLETIN 1598D	SIZE -	TYPE EEMAC/NEMA -
		TOLERANCES UNLESS OTHERWISE SPECIFIED	PURCHASED PART -		
		ANGLES ±1°	MEDIUM VOLTAGE -		
ECN NUMBER	C-1568-07	2 DECIMAL (X.XX) ±.03	OEM -		
		3 DECIMAL (X.XXX) ±.010	LIGHTENING ARRESTOR -		
REV. NO.	3	BEND RADIUS - ALLOWANCE -	REF. -		
		Rockwell Automation	A-B ORDER NO. -		

Allen-Bradley

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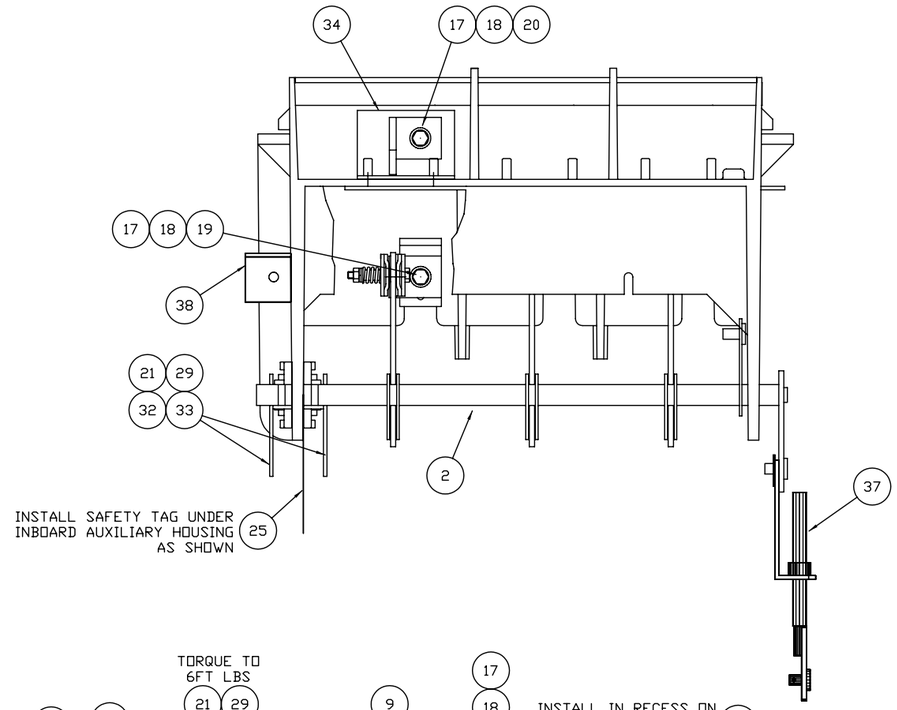
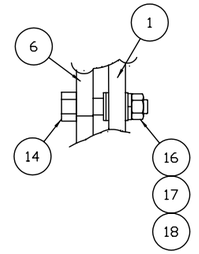
DR. LLOYD G.PEART	DATE 2003-12-10
CHKD.	DATE
SHEET 1 OF 1	DWG. NO. 80026-428

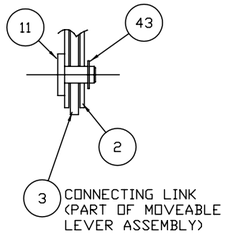
MVBBV05

Pro/ENGINEER®





SECTION B–B



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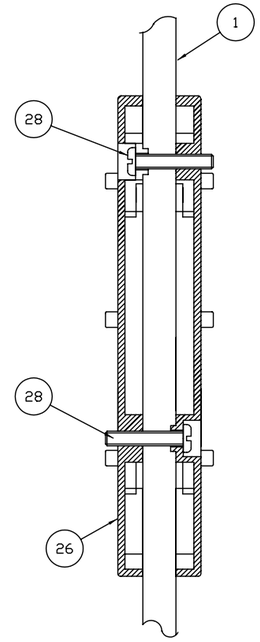

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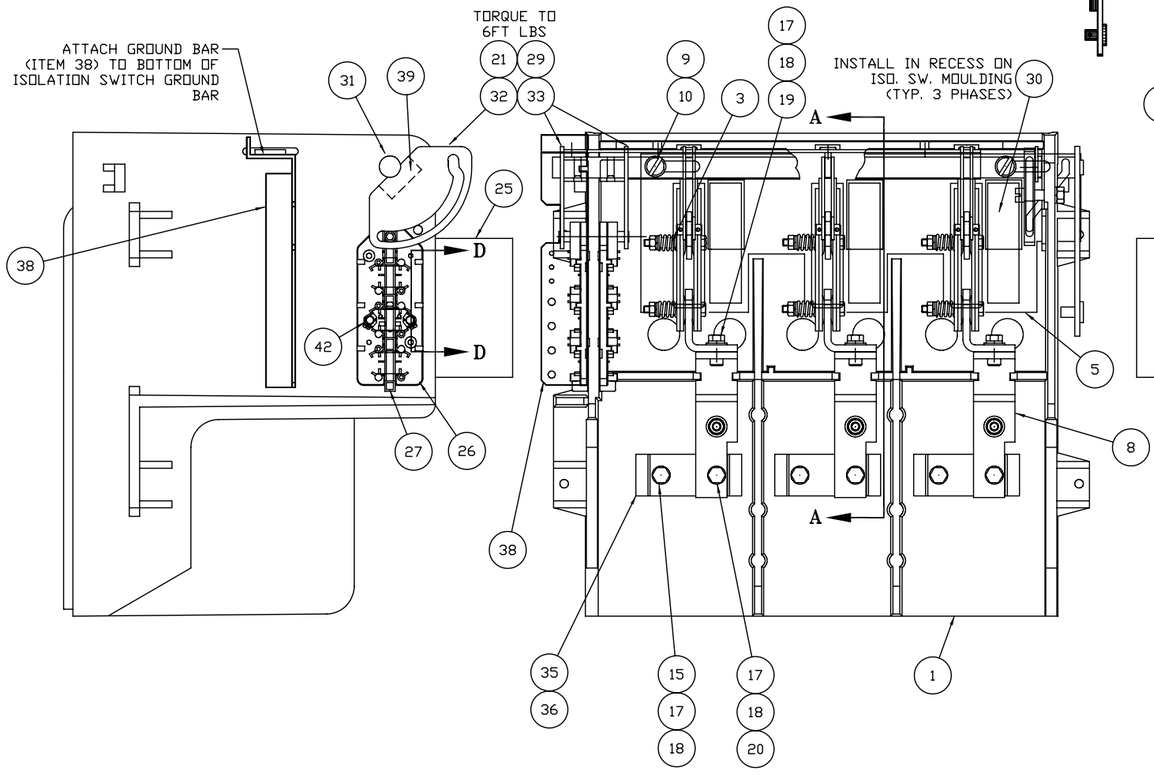

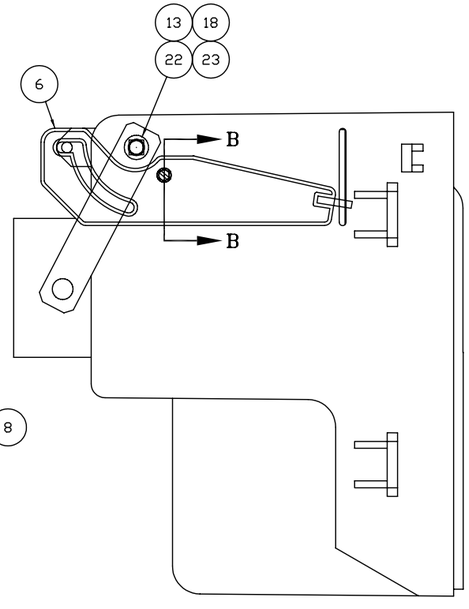

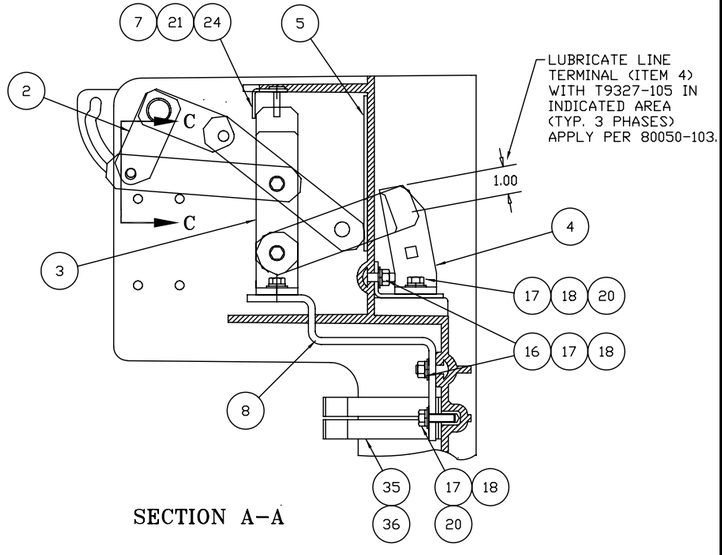

SECTION A–A

NO CLASSIFIED CHARACTERISTICS

USER ID: PVANHEES	DIMENSIONS IN INCHES	BULLETIN 1500	SIZE	TYPE NEMAC/NEMA	Allen-Bradley
	TOLERANCES UNLESS OTHERWISE SPECIFIED	ASSEMBLY			
	ANGLES ±	MEDIUM VOLTAGE			THIS DRAWING IS THE PROPERTY OF ROCKWELL INTERNATIONAL CORPORATION OR ITS SUBSIDIARIES AND MAY NOT BE COPIED USED OR DISCLOSED FOR ANY PURPOSE EXCEPT AS AUTHORIZED IN WRITING BY ROCKWELL INTERNATIONAL CORPORATION
ECN NUMBER: C-1884-07	2 DECIMAL (XX) ±.03				DR. PAUL VAN HEESWYK / DATE 1997-08-25
	3 DECIMAL (XXX) ±.010				CHKD. / DATE
	BEND RADIUS ALLOWANCE	400A MOULDED ISOLATOR SWITCH CLIP ON FUSE			
REV. NO.: 18	Rockwell Automation	REF.		SHEET 1 OF 2	DWG. NO. 80154–516
		A–B ORDER NO.			

AutoCAD®

NOTE:
REVERSE CONTACTS PER 40266-515-02 AS REQUIRED FOR N.C. CONTACTS

IT.	PART NO.	DESCRIPTION	SUB-TITLE	NO AUXILIARIES	1 N.C. AUXILIARIES	2 N.C. AUXILIARIES	3 N.C. AUXILIARIES	3 N.C. AUXILIARIES	2 N.C. AUXILIARIES	1 N.O. AUXILIARY	2 N.O. AUXILIARY	3 N.O. AUXILIARY	3 N.C. AUXILIARIES		2NC OEM														
			CHG. CHAR.	14	14	14	14	14	14	14	14	14	7		2														
			ASS'Y NO.	-51	-52	-53	-54	-55	-56	-57	-58	-59	-60		-62														
				AMOUNT																								
1	80154-432-01	ISOLATING SWITCH HOUSING		1											1														
2	80154-434-52	SHAFT ASSEMBLY		1											1														
3	80158-175-51	MOVEABLE TERM. ASS'Y		3											3														
4	40195-034-02	STATIONERY LINE TERMINAL		3											3														
5	80154-431-01	MOVEABLE SHUTTER		1											1														
6	80154-428-01	SHUTTER LEVER		1											1														
7	80154-426-52	GROUND BAR		1											1														
8	80154-424-02	ISOLATOR BUS LINK		3											3														
9	40195-133-01	NYLON SHOULDER SCREW		2											2														
10	80025-182-01	5/16-18 NYLON HEX NUT		2											2														
11	80158-770-01	PIN		3											3														
12	28459-351-13	HAIR PIN COTTER		2											2														
13	M-3270	5/16 FLATWASHER .875 O/D		7											7														
14	80154-550-02	SHOULDER SCREW		1											1														
15	M-1058	5/16 X .75 H.H.C.S.		3											3														
16	M-390	5/16-18 HEX NUT		6											6														
17	M-1243	5/16 FLATWASHER		23											23														
18	M-180	5/16 LOCKWASHER		28											28														
19	M-3910	5/16-24 X .75 H.H.C.S.		3											3														
20	M-417	5/16-18 X 1.00 H.H.C.S.		3											3														
21	M-2230	1/4 FLATWASHER		12											12														
22	M-247	5/16-18 X .625 H.H.C.S.		1											1														
23	80154-548-52	DRIVE LEVER		1											1														
24	M-8770	1/4-20 X .75 H.H.T.R.S.		2											2														
25	80011-183-01	AUXILIARY SAFETY TAG		1											1														
26	80154-542-51	AUXILIARY SWITCH HOUSING		2											2														
27	80154-422-01	AUXILIARY SW CAM FOLLOWER		2											2														
28	28181-143-09	#8-18 X 7/8 P.H.T.C.S.		4											4														
29	M-6	1/4 LOCKWASHER		2											2														
30	80154-549-01	INDICATION SHEET		3											3														
31	80154-429-01	ISO. SW. SHAFT BEARING		1											1														
32	80154-451-01	AUXILIARY CAM		2											2														
33	M-489	1/4-20 X 1.00 H.H.C.S.		2											2														
34	80178-302-52	BUS STAB BRACKET ASS'Y		3											3														
35	40023-021-02	FUSE CLIP		3											3														
36	40195-022-03	FUSE CLIP SPRING		3											3														
37	80158-268-51	ADJUSTABLE ROD ASSEMBLY		1											1														
38	80158-507-51	GROUND BAR ASSEMBLY		1											1														
39	80158-561-01	ISO. SW. SHAFT CLAMP PLATE		2											2														
40																												
41	THIS DWG -51	ISOLATING SWITCH ASSEMBLY			1	1	1	1	1	1	1	1	1																
42	40266-515-01	AUXILIARY CONTACT			2	4	4	5	3	1	2	3	6		4														
43	M-5605	E-RETAINING RING		3											3														
44	80153-280-51	REAR LINE TERMINAL ASSEMBLY													1														

REV.	ECN NUMBER	USER ID
18	C-1884-07	PVANHEES

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BULLETIN
1500

REFERENCE
-

RA ORDER NO.
-

ASSEMBLY

MEDIUM VOLTAGE

400A MOULDED ISOLATOR SWITCH

WITH CLIP-ON FUSES

Allen-Bradley

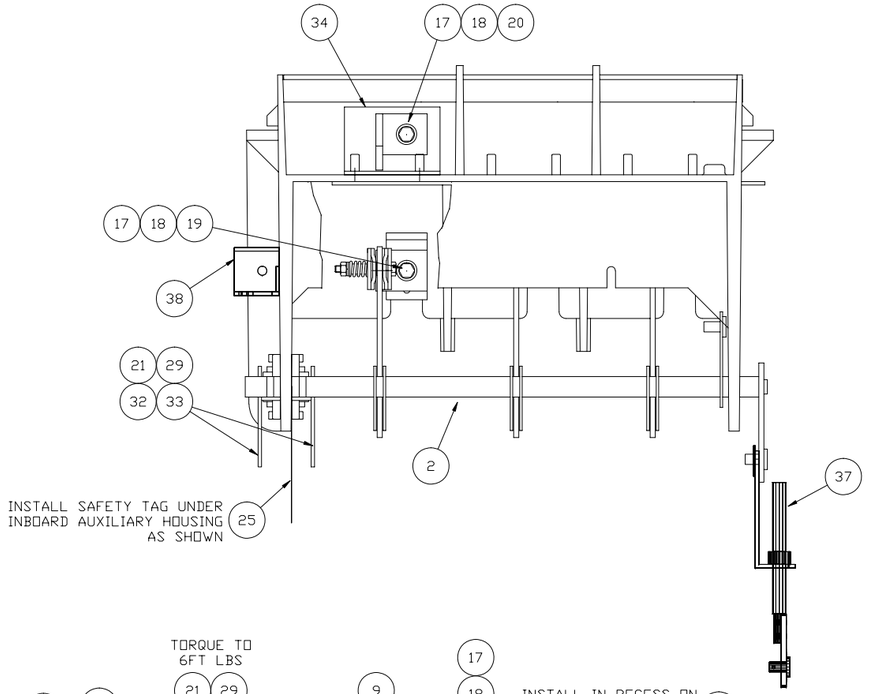
DR.	PAUL VAN HEESWYK	DATE	1997-08-25
CHKD.		DATE	

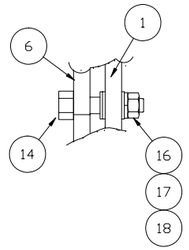
SHEET 2 OF 2

Rockwell Automation

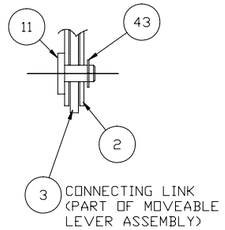
DWG. NO. **80154-516**

Excel

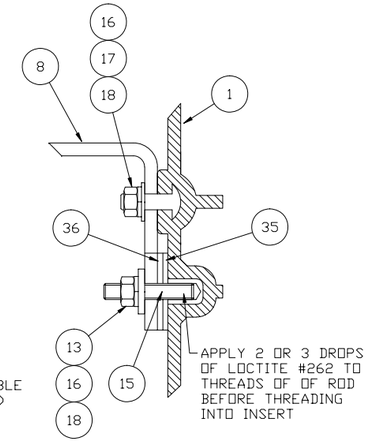




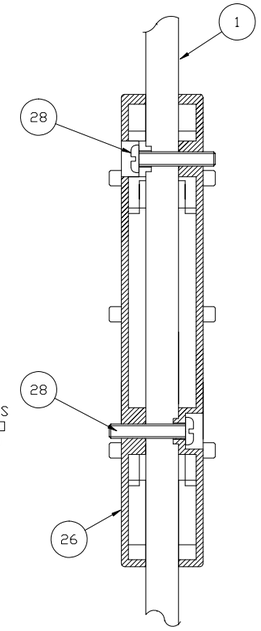
SECTION B–B



SECTION C–C



DETAIL "DA"



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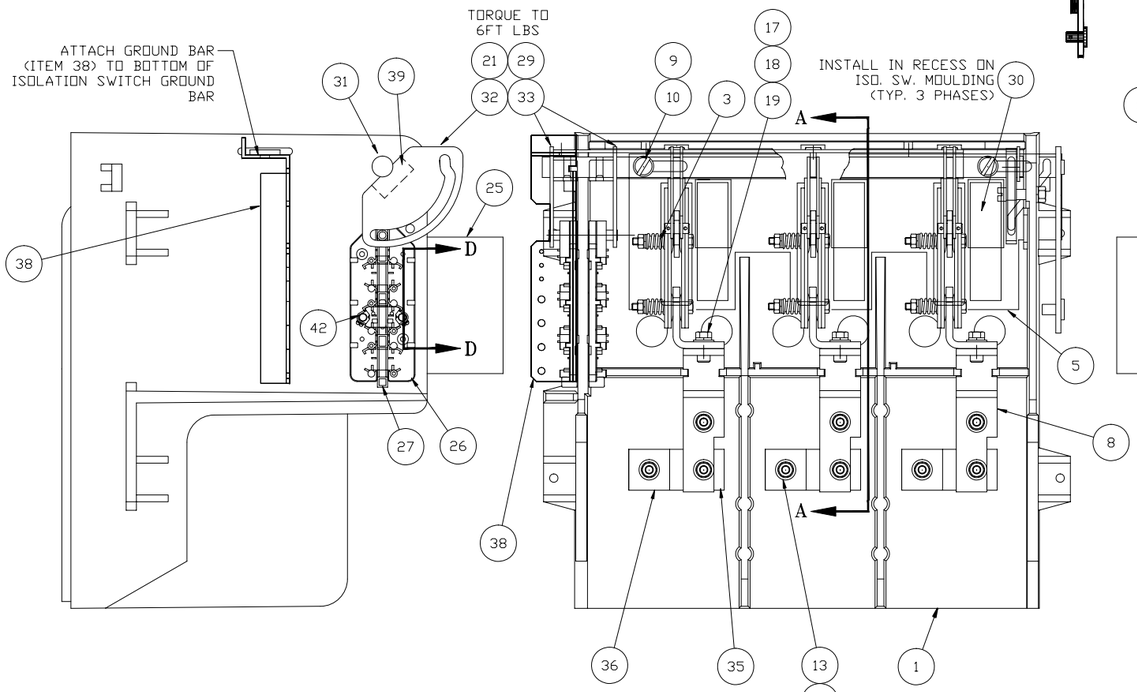

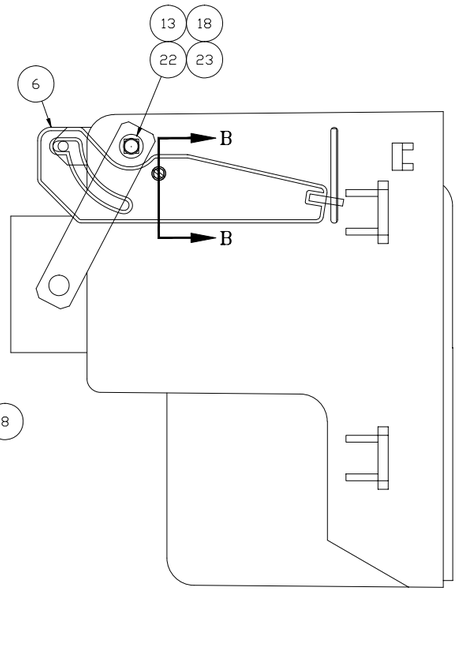

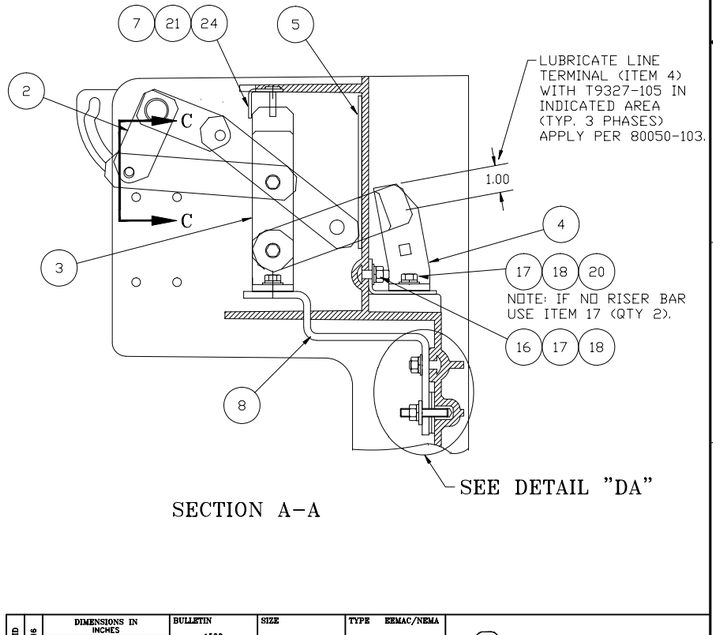

SECTION A–A

NO CLASSIFIED CHARACTERISTICS

USER ID: MSMITH6	DIMENSIONS IN INCHES	BULLETIN 1500	SIZE	TYPE NEMAC/NEMA	Allen-Bradley
	TOLERANCES UNLESS OTHERWISE SPECIFIED	ASSEMBLY			
	ANGLES ±	MEDIUM VOLTAGE			THIS DRAWING IS THE PROPERTY OF ROCKWELL INTERNATIONAL CORPORATION OR ITS SUBSIDIARIES AND MAY NOT BE COPIED USED OR DISCLOSED FOR ANY PURPOSE EXCEPT AS AUTHORIZED IN WRITING BY ROCKWELL INTERNATIONAL CORPORATION
ECN NUMBER: C-2383-08	2 DECIMAL (XX) ±.03				DR. PAUL VAN HEESWYK — DATE 1997-08-25
	3 DECIMAL (XXX) ±.010				CHKD. — DATE
REV. NO.: 22	BEND RADIUS ALLOWANCE	400A MOULDED ISOLATOR SWITCH BOLT ON FUSE			
Rockwell Automation		REF. 80153-373			SHEET 1 OF 2 — DWG. NO. 80154-544
		A-B ORDER NO.			

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NOTE:
REVERSE CONTACTS PER 40266-515-02 AS REQUIRED FOR N.C. CONTACTS

	SUB-TITLE	NO AUXILIARIES	1 N.O. AND 1 N.C. AUXILIARIES	2 N.O. AND 2 N.C. AUXILIARIES	3 N.O. AND 1 N.C. AUXILIARIES	3 N.O. AND 2 N.C. AUXILIARIES	2 N.O. AND 1 N.C. AUXILIARIES	1 N.O. AUXILIARY	2 N.O. AUXILIARY	3 N.O. AUXILIARY	3 N.O. AND 3 N.C. AUXILIARIES		2NO & 2 NC FOR OEM
CHG. CHAR.		17	17	17	17	17	17	17	17	17	9		4
ASSY NO.		-51	-52	-53	-54	-55	-56	-57	-58	-59	-60		-62

IT.	PART NO.	DESCRIPTION	AMOUNT											
1	80154-432-01	ISOLATING SWITCH HOUSING	1										1	
2	80154-434-52	SHAFT ASSEMBLY	1										1	
3	80158-175-51	MOVEABLE TERM. ASS'Y	3										3	
4	40195-034-02	STATIONERY LINE TERMINAL	3										3	
5	80154-431-01	MOVEABLE SHUTTER	1										1	
6	80154-428-01	SHUTTER LEVER	1										1	
7	80154-426-52	GROUND BAR	1										1	
8	80154-424-02	ISOLATOR BUS LINK	3										3	
9	40195-133-01	NYLON SHOULDER SCREW	2										2	
10	80025-182-01	5/16-18 NYLON HEX NUT	2										2	
11	80158-770-01	PIN	3										3	
12	28459-351-13	HAIR PIN COTTER	2										2	
13	M-3270	5/16 FLATWASHER .875 O/D	13										13	
14	80154-550-02	SHOULDER SCREW	1										1	
15	80016-026-02	5/16-18 HEX SOCKET SET SCREW	6										6	
16	M-390	5/16-18 HEX NUT	15										15	
17	M-1243	5/16 FLATWASHER	20										20	
18	M-180	5/16 LOCKWASHER	22										22	
19	M-3910	5/16-24 X .75 H.H.C.S.	3										3	
20	M-471	5/16-18 X 1.25 H.H.C.S.	3										3	
21	M-2230	1/4 FLATWASHER	12										12	
22	M-247	5/16-18 X .625 H.H.C.S.	1										1	
23	80154-548-52	DRIVE LEVER	1										1	
24	M-8770	1/4-20 X .75 H.H.T.R.S.	2										2	
25	80011-183-01	AUXILIARY SAFETY TAG	1										1	
26	80154-542-51	AUXILIARY SWITCH HOUSING	2										2	
27	80154-422-01	AUXILIARY SW CAM FOLLOWER	2										2	
28	28181-143-09	#8-18 X 7/8 P.H.T.C.S.	4										4	
29	M-6	1/4 LOCKWASHER	2										2	
30	80154-549-01	INDICATION SHEET	3										3	
31	80154-429-01	ISO. SW. SHAFT BEARING	1										1	
32	80154-451-01	AUXILIARY CAM	2										2	
33	M-489	1/4-20 X 1.00 H.H.C.S.	2										2	
34	80178-302-52	BUS STAB BRACKET ASS'Y	3										3	
35	80154-546-02	SPACER	6										6	
36	80153-131-02	SPACER	3										3	
37	80158-268-51	ADJUSTABLE ROD ASSEMBLY	1										1	
38	80158-507-51	GROUND BAR ASSEMBLY	1										1	
39	80158-561-01	ISO. SW. SHAFT CLAMP PLATE	2										2	
41	THIS DWG -51	ISOLATING SWITCH ASSEMBLY		1	1	1	1	1	1	1	1	1		
42	40266-515-01	AUXILIARY CONTACT		2	4	4	5	3	1	2	3	6	4	
43	M-5605	E-RETAINING RING	3										3	
44	80153-280-51	REAR LINE TERMINAL ASSEMBLY											1	

REV.	ECN NUMBER	USER ID	ASSEMBLY
22	C-2383-08	MSMITH6	
		BULLETIN	MEDIUM VOLTAGE
		1500	
REFERENCE			
-			
RA ORDER NO.			400A MOULDED ISOLATOR SWITCH
-			WITH BOLT-ON FUSES

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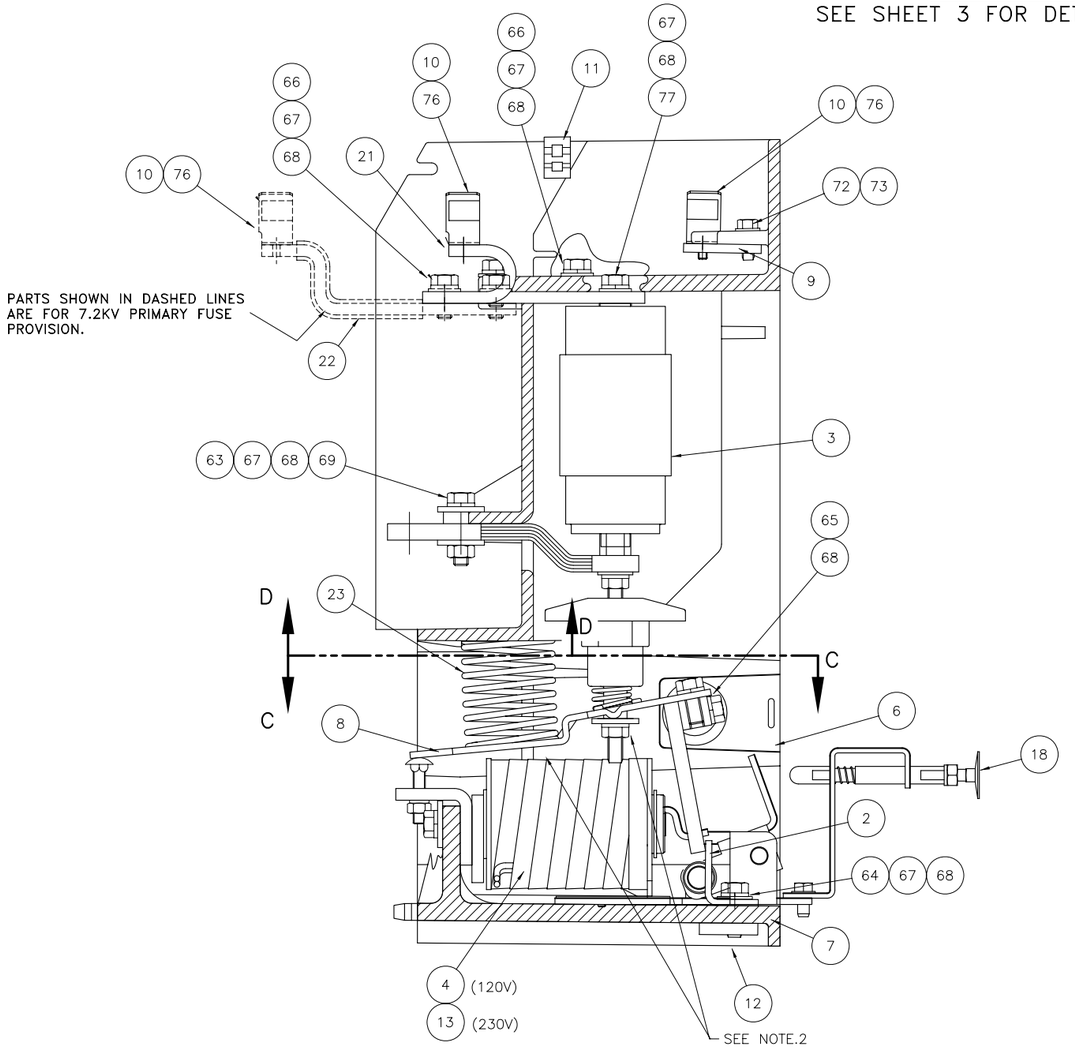
Allen-Bradley

DR.	PAUL VAN HEESWYK	DATE	1997-08-25
CHKD.		DATE	
SHEET	2	DWG. NO.	80154-544
OF	2		

Rockwell Automation

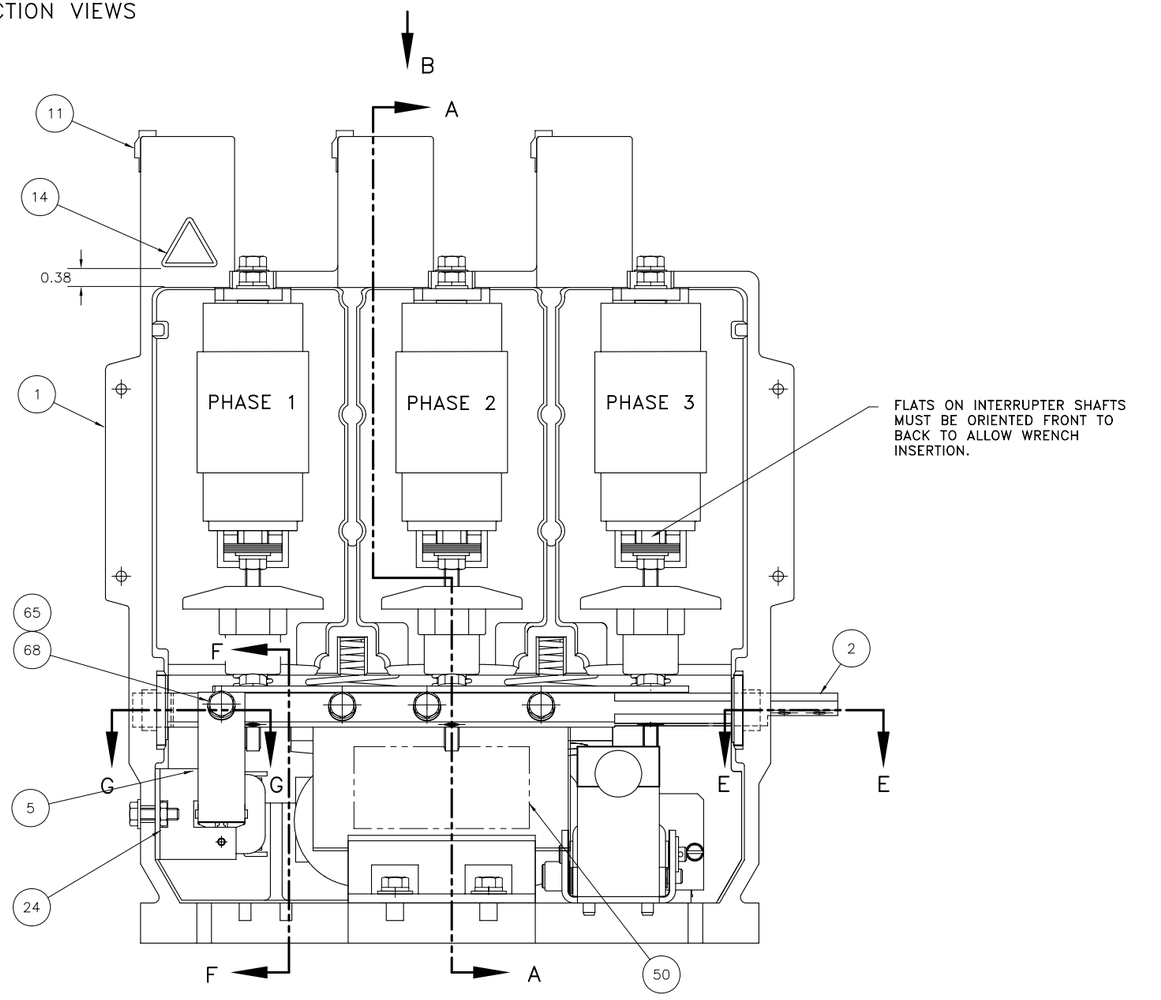
Excel

ASSEMBLIES −51 THRU −60 &
−71 THRU −73 SHOWN
SEE SHEET 3 FOR DETAIL & SECTION VIEWS



SECTION A−A

(SOME CROSSHATCHING OMITTED FOR CLARITY)



NOTES

1. NOMINAL CONTACT GAP = 0.190"
2. LUBRICATE MATING SURFACES OF ACTUATOR PLATE, WASHER AND SPRING WITH NYOGEL 759G T9327−105
3. WEIGHT = 49 LB.
4. TORQUE 5/16" HARDWARE TO 132 IN−LB
5. TORQUE 1/4" HARDWARE TO 72 IN−LB
6. HIGH ALTITUDE COMPENSATION IS PROVIDED ON THE INTELLIVAC CONTROL MODULE
7. DIMENSION DRAWING REFERENCE: 80154−275

USER ID: PBREWER	DIMENSIONS IN INCHES	BULLETIN 1502	SIZE	TYPE EEMAC/NEMA	Allen-Bradley
	TOLERANCES UNLESS OTHERWISE SPECIFIED	ASSEMBLY			
	ANGLES ±1°	VACUUM CONTACTOR			
ECN NUMBER: C-1056-06	2 DECIMAL (XX) ±.03	MEDIUM VOLTAGE			
	3 DECIMAL (XXX) ±.010	SERIES E 400A, 7.2KV, MECHANICALLY LATCHED			
	BEND RADIUS ALLOWANCE	INTELLIVAC CONTROL			
REV. NO.: 3	Rockwell Automation	REF. 80158−819		SHEET 1 OF 4	DWG. NO. 80158−908
		A−B ORDER NO.			

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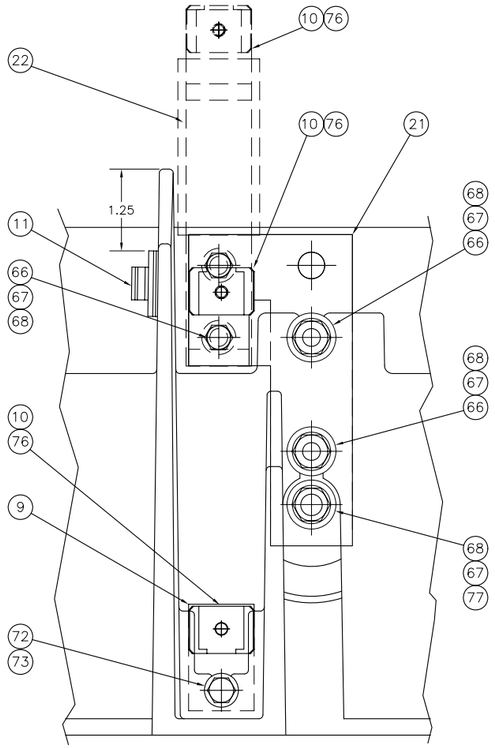
DR. PAUL BREWER DATE 2003-12-10

CHKD. DATE

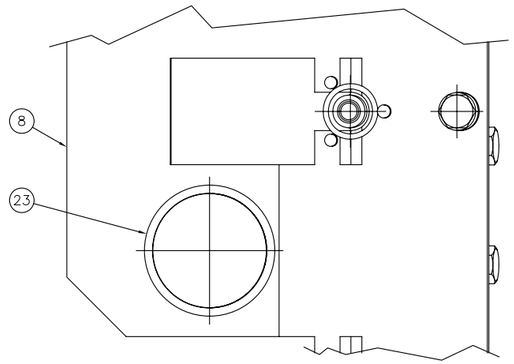
MVBDH03

AutoCAD®

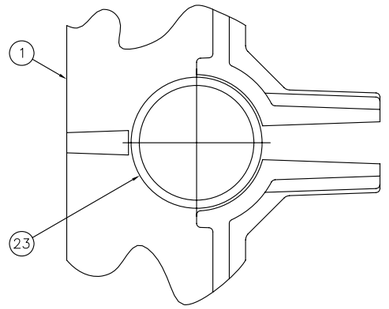


VIEW B

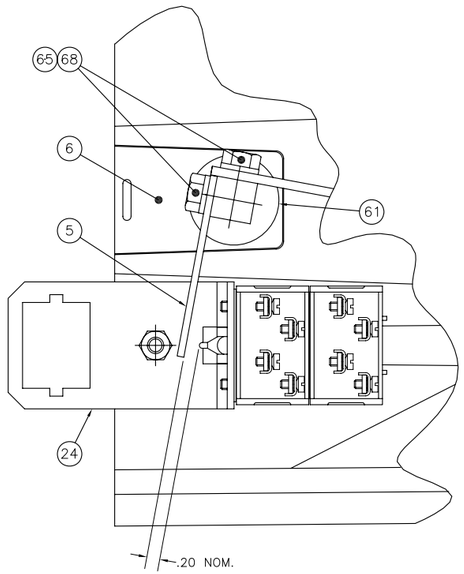
(TYPICAL ALL PHASES)



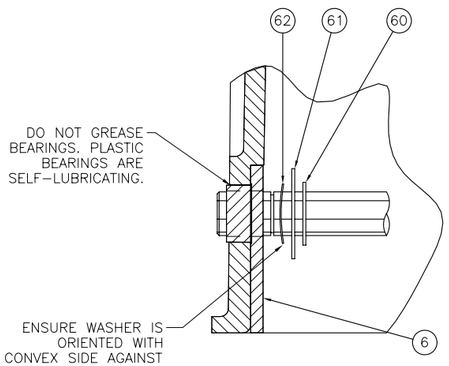
SECTION C–C



SECTION D–D

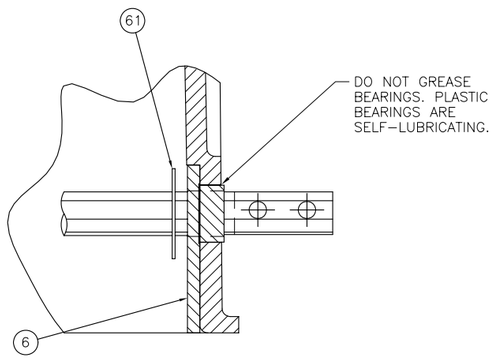


SECTION F–F



SECTION G–G

(EXPLODED FOR CLARITY)



SECTION E–E

(EXPLODED FOR CLARITY)

USER ID: PBREWER	DIMENSIONS IN INCHES	BULLETIN 1502	SIZE	TYPE EEMAC/NEMA
	TOLERANCES UNLESS OTHERWISE SPECIFIED	ASSEMBLY		
	ANGLES ±1°	VACUUM CONTACTOR		
ECN NUMBER: C-1056-06	2 DECIMAL (XX) ±.03	MEDIUM VOLTAGE		
	3 DECIMAL (XXX) ±.010	SERIES E 400A, 7.2KV, MECHANICALLY LATCHED		
	BEND RADIUS ALLOWANCE	INTELLIVAC CONTROL		
REV. NO.: 3	Rockwell Automation	REF. 80158-819	SHEET 3 OF 4	DWG. NO. 80158-908
		A-B ORDER NO.		

Allen-Bradley

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DR. PAUL BREWER DATE 2003-12-10

CHKD. DATE

MVBDH03

AutoCAD®

AMOUNT				PART NO.	DESCRIPTION	IT.
		1		80158-698-01	CONTACTOR BASE	1
		1		80153-550-51	MAIN SHAFT ASSEMBLY	2
		3		80153-556-51	VACUUM BOTTLE ASSEMBLY	3
		1		80158-745-51	COIL & CORE ASSEMBLY	4
		1		80153-553-02	AUXILIARY ACTUATOR	5
		2		80153-564-01	BEARING	6
		1		80153-565-01	FRONT STOP	7
		1		80153-566-02	SPRING ACTUATOR PLATE	8
		3		80153-570-02	FUSE BUS TAB	9
		6		G-6618	FUSE CLIP	10
		3		80026-473-01	METAL CLIP	11
		2		80157-211-02	FRONT STOP BOLT RETAINER	12
						13
		1		80006-334-01	LIFTING HAZARD LABEL	14
		1		80158-672-51	MECHANICAL LATCH ASSEMBLY	18
1	1	1		80158-908-51	BASIC ASSEMBLY	20
3		3		80153-569-02	LINE TERMINAL 5KV FP	21
	3			80156-765-02	LINE TERMINAL 7.2KV FP	·
	3			80156-767-52	FUSE BUS TAB ASSEMBLY	22
2	2	2		80153-567-01	RETURN SPRING 0-1000M	23
				80158-743-52	AUXILIARY CONTACTS ASSEMBLY E.H.	24
		1		80158-744-52	AUXILIARY CONTACTS ASSEMBLY M.L.	
2				80157-194-51	PHASE 1 FINGER ASSEMBLY	25
2				80157-194-52	PHASE 2 FINGER ASSEMBLY	26
2				80157-194-53	PHASE 3 FINGER ASSEMBLY	27
1				80157-202-01	LEVER ARM	28
3				80157-198-02	CCT PLUG BRACKET	29
6				80018-491-01	CCT PLUG WIRE	30
3				80025-592-01	CCT PLUG	31
1				80157-199-52	HANDLE ASSEMBLY	33
		1		80010-319-07	RATING LABEL	50
	1			80010-319-08	RATING LABEL	
1				80010-319-09	RATING LABEL	
1				80006-229-01	LABEL FOR CONTACTOR ENGAGEMENT	55
		1		28325-523-25	"E" RING	60
		2		28300-096-26	FLATWASHER .046 THICK	61
		1		28311-017-01	BOWED WASHER	62
		3		M-471	5/16-18 X 1.25 HHCS	63
		2		M-417	5/16-18 X 1.00 HHCS	64
		4		M-1058	5/16-18 X .75 HHCS	65
	6	6		M-3910	5/16-24 X .75 HHCS	66
	6	17		M-1243	5/16 FLATWASHER	67
	6	18		M-180	5/16 LOCKWASHER	68
		3		M-390	5/16 - 18 HEX NUT	69
				M-1256	1/4 - 20 X 1.50 HHCS	70
6				M-489	1/4-20 X 1.00 HHCS	71
		3		M-8770	1/4 -20 X .75 HHTRS	72
6		3		M-2230	1/4 FLATWASHER	73
6				M-6	1/4 LOCKWASHER	74
4				M-7	1/4 -20 HEX NUT	75
		6		M-8764	10-32 X .38 HHTRS	76
		3		28107-107-01	5/16-24 X 1.00 HHCS	77
		X		80113-649-24	WD & SCH. M.L.	
6				28355-101-25	3/8-16 WASHER NUT CONICAL	
6				M-353	3/8 FLAT WASHER 1.13 O.D.	78
6				M-131	3/8-16 X 1.25 HHCS	79
6				M-733	3/8 FLAT WASHER 3/4 O.D.	80
						81

CHG. CHAR.	ASSEM. NO.	SUB-TITLE
3	-54	ML DO 5 KV FP -1000 - 5000M
3	-53	ML 7.2 KV FP -1000 - 5000M
3	-52	ML 5 KV FP -1000 - 5000M
3	-51	ML BASIC ASSEMBLY -1000 - 5000M

DO - DRAW OUT

FP - PRIMARY FUSE MOUNTING PROVISION

ML - MECHANICAL LATCH

USER ID: PBREWER
ECN NUMBER: C-1056-06
REV. NO.: 3

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGLES ±1°
2 DECIMAL (XX) ±.03
3 DECIMAL (XXX) ±.010
BEND RADIUS ALLOWANCE

Rockwell Automation

BULLETIN 1502 | SIZE | TYPE EEMAC/NEMA

ASSEMBLY
VACUUM CONTACTOR
MEDIUM VOLTAGE
SERIES E 400A, 7.2KV
INTELLIVAC CONTROL
MECHANICAL LATCH

REF. 80158-691 80158-819
A-B ORDER NO.

Allen-Bradley

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DR. PAUL BREWER | DATE 2003-12-10
CHKD. | DATE

SHEET 4 OF 4
DWG. NO. 80158-908

MVBDV03

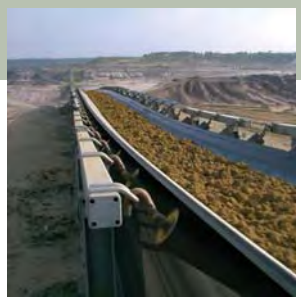
AutoCAD®

LISTEN.
THINK.
SOLVE.®

MEDIUM VOLTAGE CONTROLLERS

CENTERLINE®

MEDIUM VOLTAGE MOTOR CONTROL



Manufacturers share the challenge of efficiently controlling motors to improve performance, reduce power consumption and protect motor investment. Of all the motors in your manufacturing process, medium voltage motors can have a large impact on your continued success. Developing medium voltage motor control and protection has been a core discipline for Rockwell Automation® for more than 100 years. Medium Voltage products, from across-the-line starters to soft starters and variable frequency AC drives, deliver enhanced protection in applications ranging up to several thousand horsepower. Bringing motors up to speed in a controlled manner, limiting wear on the motor and other mechanical components, and protecting your investment are key benefits of Rockwell Automation medium voltage systems.

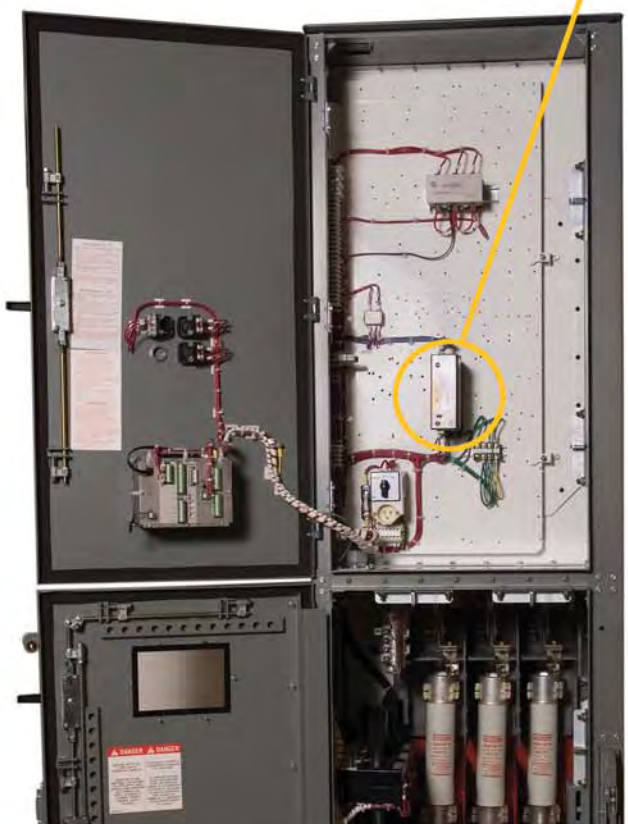
O.E.M. frames and components provide OEMs and electrical equipment companies with custom-engineered solutions and high quality components. Both the medium voltage controller and SMC product lines offer smaller, more flexible individual components to reduce building and expansion costs. Open-frame style structures are also available with most medium voltage components already mounted within the frame. All OEM components are manufactured to meet UL, CSA, CE and IEC standards.

Allen-Bradley® medium voltage motor controllers are available in a wide range of control formats allowing the flexibility to select the best match for the application. Medium voltage full-voltage controllers, reduced voltage controllers, solid-state reduced-voltage controllers, two-speed controllers, synchronous controllers and load break switches provide integrated intelligence and the lowest cost solution for starting motors.

BUILDING BLOCKS

At Rockwell Automation, we are committed to providing the products and services that our customers demand. Over the past eighty years, Allen-Bradley medium voltage CENTERLINE® controllers have set the standard by which others are measured. Our unmatched quality and innovative designs have made us the leader in medium voltage motor control products.

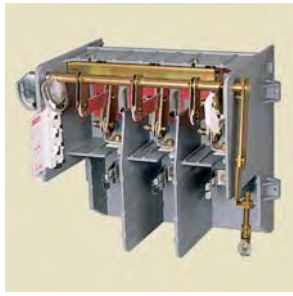
ADVANCED DIGITAL CONTROL OF VACUUM CONTACTORS



The Allen-Bradley Bulletin 1503VC IntelliVAC controller offers a superior and efficient means of controlling vacuum contactors. IntelliVAC controllers are a quantum leap beyond traditional electromechanical control circuits. Here are just a few of the beneficial characteristics:

- The performance and flexibility of digital control, allowing the control of a wide array of contactor types (400A, 800A electrically held, and mechanical latch)
- Enhanced reliability as a result of embedded self diagnostics and better coordination between unit power fuses and the vacuum contactor drop-out time
- Increased productivity with features like power loss ride through (TDUV) and contactor anti-kiss, which were previously offered as optional features
- Motor and process protection with delayed restart built-in

NON-LOAD BREAK ISOLATION SWITCH



- Electrical and mechanical interlocks prevent the switch from opening when the contactor is energized
- Ensures normal operation only when the switch is fully closed
- Allows for separate source testing when in the “OFF” position
- Grounded in the “OFF” position
- When in the open position, a visible barrier isolates the power cell from the power bus compartment
- Status of the isolation switch can be viewed through a window in the power cell door

HANDLE AND INTERLOCK MECHANISM

- Simple direct drive mechanism improves reliability and ensures operator safety
- Mechanical interlock mechanism remains part of the enclosure to eliminate setup adjustment
- Power cell door is interlocked with the handle mechanism to prevent the door from being opened when the cell is energized

LOW VOLTAGE COMPARTMENT

- Separate 120 volt source is required for “Test” position control power
- Allows testing and troubleshooting of the power cell without exposing personnel to medium voltage
- Prevents backfeeding medium voltage through the control transformer, in “Test” mode
- All low voltage components are located in the low voltage panel
- Low voltage panel interior painted white for better visibility

POWER CELL COMPARTMENT

- Power cell, low voltage panel, and bus compartment are isolated from each other for better fault containment
- Swing out low voltage panel for easy access to install load cables
- Isolated load cable compartments between top and bottom power cell
- Easy access for cable installation and stress cones
- Bar type current transformers are supplied as standard for overload protection and metering

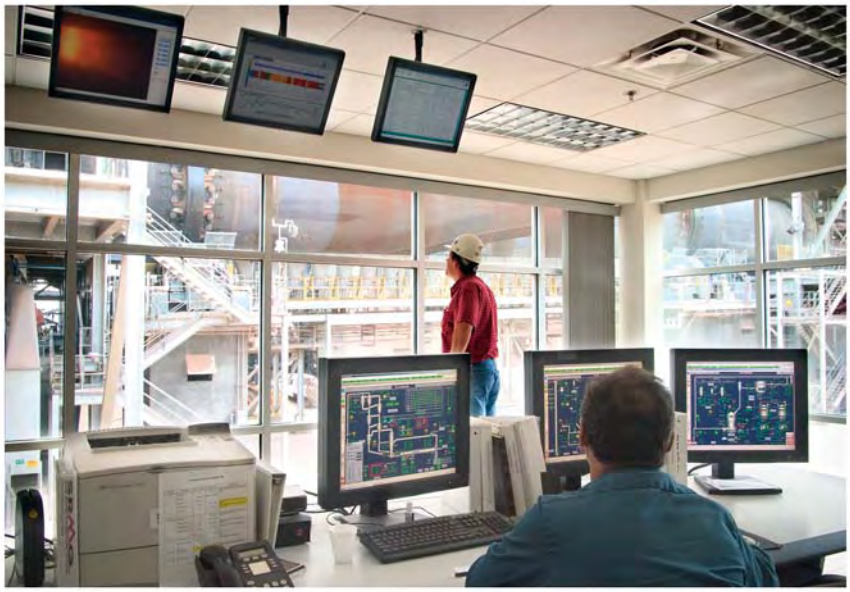
POWER BUS COMPARTMENT

- CENTERLINE bus designed as an integral part of the structure
- Dissipates heat more efficiently
- Edge-to-edge configuration maximizes resistance to magnetic forces and minimizes moisture or dust collection
- Molded bus brace reduces maintenance and provides better distribution of forces during a fault
- Accessible without a ladder, for installation and maintenance
- Allows for incoming line cables to enter through the top or bottom of the compartment

INTELLIGENT MOTOR CONTROL

OPTIMIZE PLANT PERFORMANCE & PROTECT YOUR INVESTMENT

We understand that you need to control performance, reduce downtime, improve safety, increase productivity, and perform diagnostics. That's why we've combined leading-edge motor control and protection devices with the advanced networking and diagnostic capabilities of Rockwell Automation's Integrated Architecture to provide you with Intelligent Motor Control.



PROTECTION

Thanks to integrated I/O and advanced diagnostic and protection capabilities, all Intelligent Motor Control products constantly monitor the motor operation to help you follow performance trends and take remedial action before potential failures occur. Reduce unwanted downtime by 75% while increasing overall production efficiency by 10% or more.

COMMUNICATIONS

Because you have a wide range of application needs, Intelligent Motor Control offers a variety of motor control technologies.

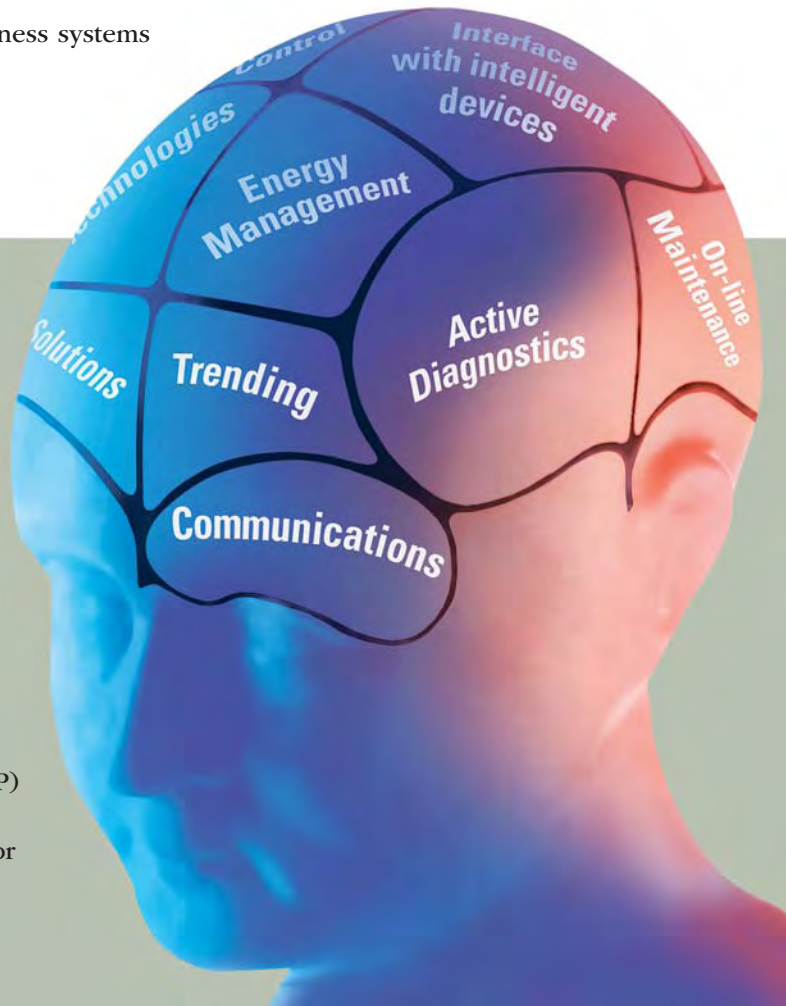
Simplified control technologies are designed to suit your needs

- DeviceLogix™ component technology increases the control possibilities with function block diagrams that operate at the device level
- DriveLogix™ offers embedded Login control for application programmability and control of auxiliary functions in one package

SCALABLE FUNCTIONALITY

Integrated Architecture enables you to reduce your total cost of ownership by using a single control infrastructure for the entire range of factory automation applications, large or small

- Reuse engineering designs and practices to reduce development time and cost
- Quickly respond to customer or market demands
- Reduce maintenance costs and downtime
- Easily access plant and production data from business systems or better management decision-making



COMMUNICATIONS

The key to intelligence in motor control...

Utilize open networked architecture to enhance motor protection, share diagnostic information and speed troubleshooting for a more productive, "intelligent" process.

- From simple I/O to complex power monitoring tasks, DeviceNet™ lets your cost effectively integrate many low-level manufacturing functions
- NetLinx open network technology provides seamless communications throughout your enterprise (DeviceNet, ControlNet, and EtherNet/IP)
- Flexibility and commonality of communications across the product offering makes Intelligent Motor Control easy to use

O.E.M. PRODUCTS

QUALITY COMPONENTS FOR THE OEM MARKET

OEM Frames and components leverage the existing family of motor controllers built by Rockwell Automation. They also incorporate some of the most fundamental, high volume components available in our OEM product line for Original Equipment Manufacturers and electrical equipment companies.

Bulletin 1502 vacuum contactors are a comprehensive line of vacuum contactors used as isolating contactors or as bypass contactors. Light weight and maintainability are but two of the features of this fixed-mounted design.

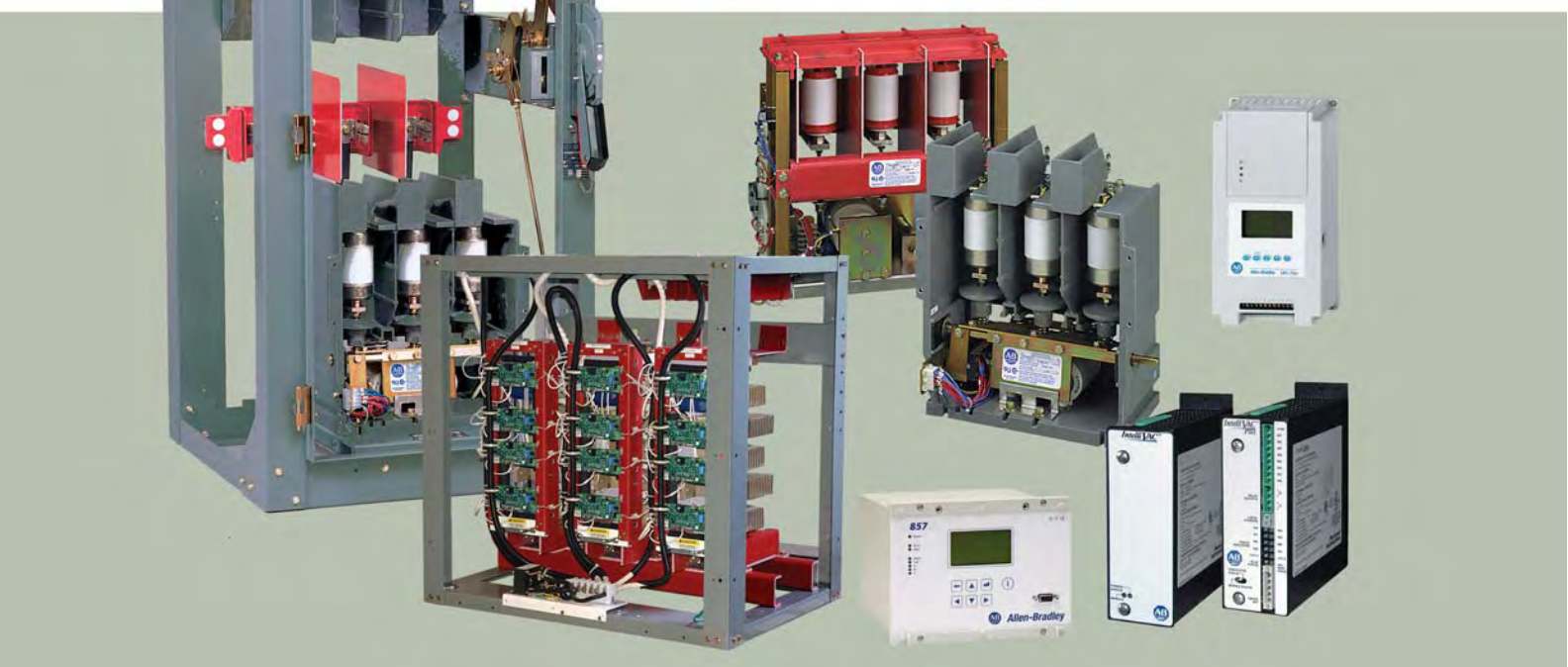
Bulletin 1503F OEM components are a series of medium voltage frame-mounted components designed to mount into new or existing structures or enclosures. These assemblies can also be used to retrofit existing motor controllers. These products are available as a complete OEM frame or sold individually as components.

Bulletin 1503E MV SMC™ Flex OEM kits are a series of solid-state reduced voltage components designed to mount into new or existing structures or enclosures. These assemblies can also be used to retrofit existing motor controllers. These products are available as an OEM frame and components.

The Bulletin 857 motor and feeder protection device includes all the essential protection functions needed to protect feeders and motors in distribution networks of utilities, heavy industry, power plants and offshore applications. The Bulletin 857 can also be used to retrofit existing motor controllers.

The IntelliVAC control module is an efficient and flexible solution for controlling medium voltage contactors used in motor starter and feeder applications. The IntelliVAC control model manages 400 and 800 amp contactors, as well as both electrically-held and mechanically-latched contactor types.

The IntelliVAC Plus is an enhanced version of the IntelliVAC control module. Some of incremental benefits are DeviceNet communications (including IntelliCENTER software compatibility), digital I/O (8 inputs and 2 outputs), DeviceLogix control and enhanced diagnostics.



Description of Features

Designed for Safety, Convenience and Reliability

The Allen-Bradley medium voltage controller offers:

- Three isolated compartments:
  - Power bus
  - Low voltage
  - Power cell
- Large swing-out low voltage panel painted white for high visibility
- Test circuit and plug for remote control power supply
- External operating handle to operate the isolation switch
- Bolted power cell door(s)
- Centerline® horizontal power bus with removable cover plates for accessibility
- 1/4" x 2" continuous copper ground bus
- Line, load and control wire conduit openings with removable cover plates at the top or bottom of the structure
- Base mounting sill channels with mounting holes and removable lifting means
- Hybrid epoxy powder paint finish

Controller Standard Features

- NEMA Class E2 design
- Removable lifting angles or brackets
- Non-removable sill channels
- Removable backplates
- Top or bottom plates to accommodate cable entry/exit
- Tin-plated copper horizontal power bus located in an isolated compartment
- A ¼" x 2" continuous bare copper ground bus
- A main non-load break isolation switch with visible blades and shutter mechanism, and operating handle
- Mechanical and electrical interlocks between isolation switch, vacuum contactor and MV door
- Vacuum contactor(s)
- Three (3) current limiting power fuses for NEMA Class E2 operation
- Three (3) current transformers
- Control circuit transformer with primary and secondary fuses
- A low voltage control panel
- Space for necessary auxiliary control and metering devices
- Polycarbonate viewing window in power cell door
- IntelliVAC™ control module for each vacuum contactor, mounted in low voltage panel, with advanced features:
  - Universal input voltage (110-240V AC, 50/60 Hz *or* 100-250V DC)
  - Selectable vacuum contactor drop-out time and consistent pick-up time
  - Altitude compensation
  - Power loss ride-through (TDUV) – *may require additional hardware (external capacitor)*
  - Anti-kiss and anti-plugging protection
  - Delayed motor re-start and temporary motor jog function
  - One device is suitable for all contactors and control schemes

Input Voltage

- 2400V, 3300V, 4200V, 6600V or 6900V AC (+5/-10%)
- 3 phase 50/60 Hz (± 3%)

Ambient Temperature

- 0°C to 40°C (32°F to 104°F) with relative humidity of up to 95% (non-condensing)

Enclosure Types

- NEMA Type 1 – General purpose (IP10)
- NEMA Type 1 w/g – General purpose with gasket (IP21)
- NEMA Type 12 – Dust-tight and drip proof (IP52)
- NEMA Type 3R – Non walk-in weatherproof (IP34)
- Arc Resistant (NEMA Type 12) – Accessibility Type 2B – Tested per IEEE C37.20.7-2001

Standards

- Canadian Standards Association (CSA), *Industrial Control Equipment C22.2 No. 14 and TIL D-21*
- American Nation Standards Institute (ANSI), *Instrument Transformers C57.13*
- Institute of Electrical & Electronic Engineers (IEEE)
- National Electrical Code (NEC)
- Occupational Safety & Health Act (OSHA)
- Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)
- National Electrical Manufacturers Association (NEMA), *Medium Voltage Controllers Rated 1501 to 7200 V AC ICS 3-2 (formerly ICS 2-324)*
- Underwriters Laboratories, Inc. (UL), *High Voltage Industrial Control Equipment 347*
- European Directives for EMC

Description of Features (cont.)

Paint Finishes

- Description — Hybrid epoxy power paint
- Color — ANSI 49 – medium light grey (standard)
  ANSI 61 – light grey (optional)
- Procedure — Continuous paint line. All parts are painted before assembly
- Preparation — Alkaline wash/rinse/iron phosphate rinse/iron-chrome sealer rinse/recirculated de-ionized water rinse and virgin de-ionized water rinse
- Painting — Air-atomized electrostatic spray
  Total paint thickness – 0.002” (0.051 mm) minimum
- Baking — Natural gas oven at 179°C (355°F) minimum

Power Bus (Optional)

- Located at the center rear of the structure
- Mounted on the edge to a molded bus support insulator in a common vertical plane
- Centerline™ horizontal tin-plated copper bus – optional silver-plated or insulated
- 1200/2000/3000 A
- Front/rear access

Ground Bus

- Continuous bare copper ground bus 6 x 52 mm (1/4 in x 2 in) as standard
- #8 - #1/0 AWG or #6 – 250 MCM mechanical lug supplied at the incoming end of the lineup

Description of Features

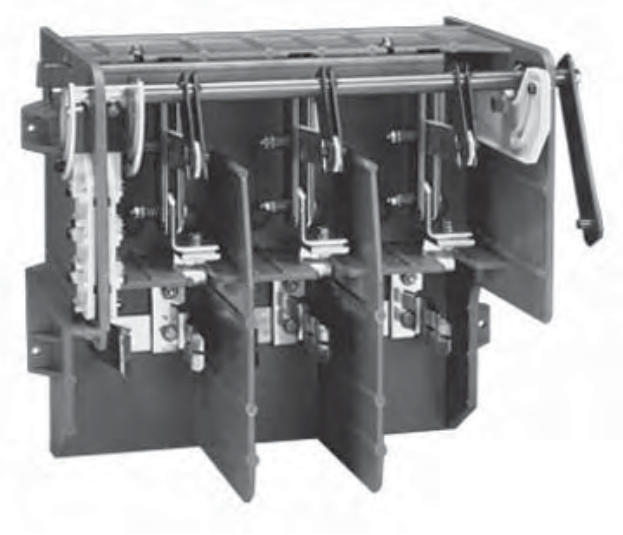
The Rockwell Automation Medium Voltage Controller, Bulletin 1500, is comprised of three core elements:

- Power cell compartment
- Low voltage compartments
- Power bus compartments

Power Cell Compartment

Isolation Switch

- Electrical and mechanical interlocks prevent the switch from opening when the contactor is energized
- Ensures normal operation only when the switch is fully closed
- Allows for separate source testing when in the “OFF” position
- Grounded in the “OFF” position



Visible Isolation

- When in the open position, a visible barrier isolates the power cell from the power bus compartment
- Status of the isolation switch can be viewed through a window in the power cell door

Isolated Cable Ducts

- Easy access for cable installation
- Ample room for stress cones
- Provides isolated load cable compartments between top and bottom power cells

Vacuum Contactor

- Modular design for simplified maintenance and reliability
- Fixed mounted design eliminates hot spots and reduces maintenance
- Visible contact wear indicator eliminates the need for special tools

Swing-out Low Voltage Panel (for 2-high structure)

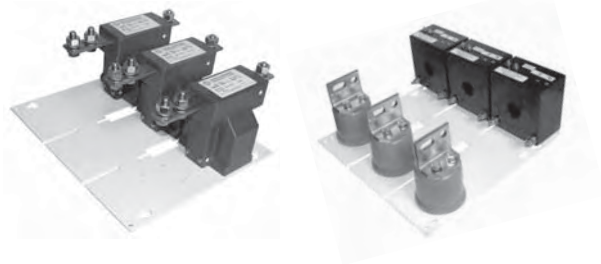
- Allows for easy access to install load cables
- Maximizes low voltage panel space

Operating Handle and Interlock Mechanism

- Simple direct drive mechanism improves reliability and ensures operator safety
- Mechanical interlock mechanism remains part of the enclosure to eliminate setup adjustment
- Power cell door is interlocked with the handle mechanism to prevent the door from being opened when the cell is energized

Current Transformers

- Three (3) current transformers are supplied as standard for overload protection and metering
- Five (5) amp secondary output

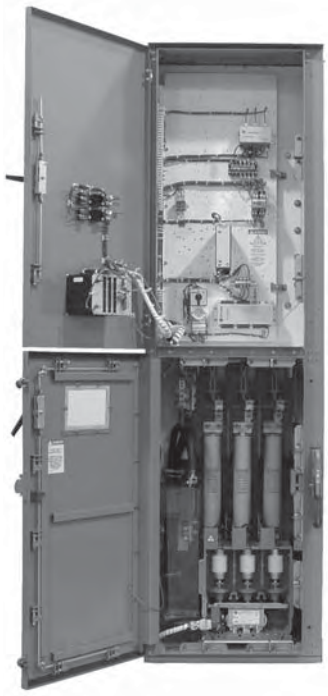


Control Power Transformers

- 110/120 or 220/240 V AC
- 500 VA as standard with 350 VA extra capacity
- Appropriately sized primary and secondary fuses
- 1000 VA, 2000 VA, and 3000 VA CPTs (optional)

Description of Features (cont.)

Low Voltage Compartment



Low Voltage Compartment Control Panel

- Separate 120 volt source is required for “Test” position control power
- Allows testing and troubleshooting of the power cell without exposing personnel to medium voltage
- Prevents backfeeding medium voltage through the control power transformer, in “Test” mode

Isolated Compartment

- All low voltage components are located in the low voltage panel
- Low voltage panel interior painted white for better visibility
- Power cell, low voltage panel, and bus compartment are isolated from each other for better fault containment
- IntelliVAC control module

Power Bus Compartment

Centerline Bus Design

- Designed as an integral part of the structure
- Dissipates heat more efficiently
- Edge-to-edge configuration maximizes resistance to magnetic forces and minimizes moisture or dust collection
- Molded bus brace reduces maintenance and provides better distribution of forces during a fault
- Accessible without a ladder, for installation and maintenance
- Allows for incoming line cables to enter through the top or bottom of the compartment

IntelliVAC

IntelliVAC Plus

Description of Features

The Allen-Bradley Bulletin 1503VC family of IntelliVAC controllers offers a superior, efficient and flexible means of controlling vacuum contactors. The IntelliVAC family offers a scalable solution for multiple medium voltage control applications. The IntelliVAC family has three main products:

- IntelliVAC provides basic control capabilities for 400 and 800 Amp contactors (electrically held and mechanical latch) using a single device. It offers enhanced reliability through better diagnostics and coordination between the power fuses and the vacuum contactor drop-out time. Productivity is improved using the power loss ride through (TDUV) and contactor anti-kiss and anti-plugging features.
- IntelliVAC Plus builds on IntelliVAC with incremental benefits such as DeviceNet communication (including IntelliCENTER software compatibility), digital I/O (8 inputs, 2 outputs), DeviceLogix™ control and enhanced diagnostics.
- IntelliVAC MC is used in multi-contactor applications, allowing one IntelliVAC Plus to control up to four IntelliVAC MC control modules in a Master-Slave configuration. Control and timing logic is handled in DeviceLogix, minimizing control hardware and wiring.

IntelliVAC controllers are designed to perform with Bulletin 1502 vacuum contactors. These industry-proven contactors are available in 400A and 800A ratings up to 7,200 volts.

IntelliVAC Control Module

- The IntelliVAC control module has a universal input voltage range (110 - 240 VAC, 50/60 Hz or 110 - 250 VDC)
- Consistent vacuum contactor pick-up time, ensures optimal synchronization
- Selectable and repeatable vacuum contactor drop-out times (50, 75, 100, 130, 150, 175, 200 or 240 msec) for tighter coordination with power fuses
- Altitude compensation (-1,000 to 5,000 meters) eliminates mechanical hardware changes at high altitude (400 Amp vacuum contactors)
- Power loss ride-through logic (TDUV) with selectable drop out time (0.2, 0.5, 1.0 or 2.0 sec) requires only an external capacitor
- Anti-kiss and anti-plugging protection
- Status indication (LEDs and relay outputs) allows integration in control system and aids troubleshooting
- Temporary motor jog function (separate input) to allow process set-up
- Delayed motor re-start prevents rapid cycling of vacuum contactor, protecting the connected motor

IntelliVAC Plus Control Module

The IntelliVAC Plus control module has the same feature as the IntelliVAC, with the additional capabilities below:

- DeviceNet communication
- DeviceLogix control
- Digital inputs (8), rated for 110 to 250 VAC or VDC, and outputs (2), rated up to 250 VAC or FDC, with all LEDs indicating status
- Support for multi-contactor (MC) control schemes, with up to four slave IntelliVAC MC units connected on RS485, and DeviceLogix pre-configured for standard MV controller logic (can also define Custom MC control configurations)
- Enhanced operational information and diagnostics with features like real-time clock, extended contactor close time monitoring and tracking of contactor usage
- IntelliCENTER software compatibility
- Configurable using either RS Networx or handheld configuration terminal (Bulletin 193-DNCT) for DeviceNet

IntelliVAC MC Control Module

The IntelliVAC MC control module has the same feature as the IntelliVAC, with the additional capabilities below:

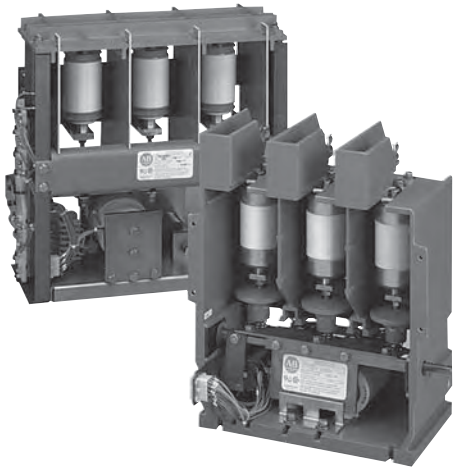
- Communication board (RS485) to allow the “MC” module to be controlled by one IntelliVAC Plus for multi-contactor control schemes

Specifications

IntelliVAC Catalog Number		Vacuum Contactor Type
1503VC-BMC5	IntelliVAC	Electrically Held or Mechanical Latch
1503VC-BMC5-EM1	IntelliVAC Plus	
1503VC-BMC5-MC1	IntelliVAC MC	Electrically Held
Ratings and Approvals ❸		
Input Voltage		AC – 110 to 240 V, 47 to 63 Hz ❶
		DC – 110 to 250 V
Input Current ❷	**AC ❶**	Inrush (max.) – 25 A (1/2 cycle)
		Idle (max.) – 125 mA
		Close (max.) – 11.3 A
		Hold (max.) – 300 mA
		Latch Trip (max.) – 7.0 A
	DC	Inrush (max.) – 25 A
		Idle (max.) – 35 mA
		Close (max.) – 4.8 A
		Hold (max.) – 100 mA
		Latch Trip (max.) – 3.7 A
Command Inputs		AC – 110 to 240 V, 9 mA max. ❶
		DC – 50 to 250 V, 9 mA max.
IntelliVAC Plus Inputs ❹		AC – 110 to 240 V, 9 mA max. ❶
		DC – 50 to 250 V, 9 mA max.
Status Output Contacts		AC – 250 V, 5 A, R load ❶
		DC – 30 V, 5 A, R load
IntelliVAC Plus Output Contacts ❹		AC – 250 V, 5 A, R load ❶
		DC – 30 V, 5 A, R load
Standards and Approval		cULus, CSA, IEC, CE

❶ All AC values are rms, except where noted.
❷ The maximum currents shown are for either the 400 or 800 A Bulletin 1502 vacuum contactors. Close current duration is 200 milliseconds.
❸ Common ratings for all versions of IntelliVAC, except where noted.
❹ Available with IntelliVAC Plus (1503VC-EMC1) only.

Medium Voltage Controller Components – Vacuum Contactors



Description of Features

The Allen-Bradley vacuum contactors are designed as fixed mounted devices for heavy-duty industrial performance. This design eliminates the worries typically associated with drawout contactors.

The compact design of the contactor eliminates the need for it to be removed from the power cell. Also there are no drawout stab and finger assemblies, which require routine maintenance.

The Series E contactors are designed for operation with Rockwell Automation's IntelliVAC family of control modules.

Advantages

- Lightweight, compact design
- High interrupting capability
- Low chop current
- Visual contact wear indicator (no measurement tools required)
- Provisions for mechanical interlocking (to isolation switch)
- Excellent dielectric recovery allowing for high switching frequency
- Single coil/core magnet assembly (800 A only)
- Control power transformer primary fuse holders (400 A only)
- Minimal maintenance required
- All major components are easily accessed from the front
- Mechanical latch design (optional)
- Easily integrated into control circuit with quick connector and wire harness (optional)
- Designed to complement the advanced features of the IntelliVAC contactor control module

Applications

Medium Voltage (1,000 to 7,200 V) vacuum switching for:

- Motor Starters (asynchronous, synchronous)
  - Full voltage
  - Reduced voltage
  - Variable frequency drives
- Transformer feeder units
- Capacitors

Product Approvals

- UL347
- CSA 22.2 No. 14 and TIL D-21
- IEC 60470
- CE Mark

Modular Construction

- Designed to be interchangeable with other contactors of the same rating
- Horsepower rated devices are located elsewhere in the power cell, not on the contactor
- Easily removed for maintenance and repair

Vacuum Bottles

- Designed to industry specifications
- Arcing confined inside vacuum bottle for ionized gas protection
- Mounted on the front of the contactor for visible inspection
- Contact wear indicators located on the bottle eliminates the need for special tools
- Excellent dielectric recovery provides high switching frequency

Long Electrical and Mechanical Life

- 1,000,000 electrical operations (400 A)
- 2,500,000 mechanical operations (400 A)

Specifications

Bulletin 1502 Medium Voltage Contactor Ratings			400 A	800 A
Voltage Ratings ❶				
Maximum Rated Voltage			7200	7200
System Voltages			2400 3300 4160 4800 6600 6900	
Dielectric Voltage Withstand Rating	For 60 seconds (kV)		18.2 / 20 kV (IEC)	
Basic Impulse Level (B.I.L.) Withstand	Phase to Ground, Phase to Phase (kV)		60	60
Frequency Ratings	Hertz		50/60	50/60
Current Ratings ❶				
Rated Open Continuous Current			400	800
Maximum Interrupting Current Rating (RMS Sym Amps)	2400 V		6300	12500
	5000 V		6300	12500
	7200 V ❷		6000	12500
Maximum Interrupting MVA Rating (Sym MVA)	2400 V		25	50
	5000 V		50	100
	7200 V ❷		75	150
Short-Circuit Withstand at Rated Voltage	Current Peak ½ cycle (kA)		60	85
Short Time Current Rating Capability	For 1 second (kA)		6.0	12.0
	For 30 seconds (kA)		2.4	4.8
Chop Current (Average RMS Amps)			0.5	0.5
Make and Break Capability at Rated Voltage (kA)			4.0	8.0
Ambient Temperature	°C		40	40
Contactor Coil Data				
110 to 240 V AC or 110 to 250 V DC ❻	V AC: $V_{CL} = \sqrt{2} \times V_{CTL}$ (Max.) V DC: $V_{CL} = V_{CTL}$	Close Current (A_{DC}, 200 ms)	4.3	12
		Hold Current (A_{DC})	.248	0.7
		Pick-up Voltage ❻	95	95
		Drop-out Voltage ❻	75	75
		Trip Current (A_{DC}, 200 ms) ❼	5.5	5.2
		Trip Voltage ❻❼	70	70
Operational Characteristics				
Mechanical Life (Operations) x 1000 ❸	Electrically Held		2500	250
	Mechanical Latch		100	100
Electrical Life (Operations) x 1000 ❸			1000	250
Switching Frequency (Operations per hour)	Electrically Held		600	600
	Mechanical Latch		150	150
Capacitor Switching (max. kVAR)	System Voltage	2400 V	800	2000
		4160 V	1400	3000
		6900 V	2000	4000
General				
Standard Altitude Capabilities (meters / feet) ❶			-1000 to 5000 / -3300 to 16500 ❹	-1000 to 5000 / -3300 to 16500 ❽
Contactor Weight (kg / lbs)			21.8 / 48	45 / 100
Auxiliary Contact Rating			A600	A600
Auxiliary Contacts on the Vacuum Contactor (max.) ❺			3 N.O. / 3. N.C.	3 N.O. / 3. N.C.

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet).
❷ The IEC rating at 7200 V (RMS Sym.) is 5300 amps / 66 MVA.
❸ Provided that regular maintenance is performed, as detailed in publication 1500-SR020_-EN-P.
❹ The full altitude range is available with the IntelliVAC control module only, and the IntelliVAC is to be configured accordingly (refer to publication 1503-UM051_-EN-P). The standard mechanical latch contactors, if used with electro-mechanical control, are designed for -1000 to 1000 meters (-3300 to 3300 feet). Higher altitudes are possible by changing the contactor return springs.
❺ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes.
❻ Control voltage, as measured at the input of the IntelliVAC module.
❼ Applicable to mechanical latch contactors only.
❽ Altitude is field adjustable using a mechanical arrangement.

Medium Voltage Controller – Full Voltage Non-Reversing (Two-High) Starter

400 Amp

Description of Features

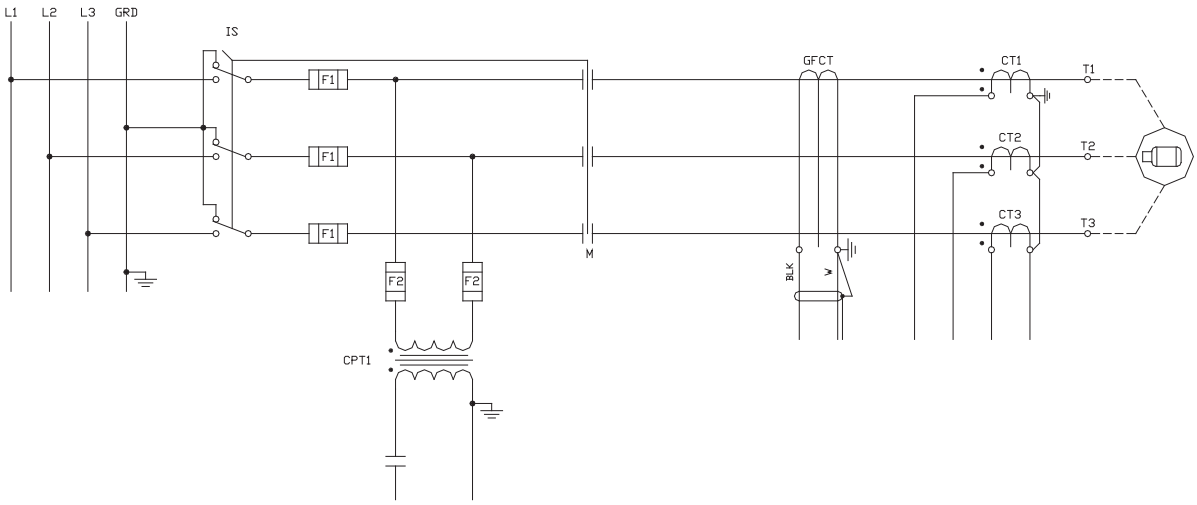
- Fixed mounted vacuum contactor
- Three-pole, gang-operated, non-load break isolating switch with an external operating handle, fully interlocked with main contactor and power cell doors
- A polycarbonate viewing window in the power cell door to view the position of the isolating switch
- Three (3) R-rated current-limiting power fuses
- Three (3) current transformers
- Control power transformer with primary and secondary fuses
- Segregated low voltage panel to house standard and optional hardware for unit control and monitoring
- IntelliVAC™ control module for each vacuum contactor, mounted in low voltage panel, with advanced features:
- Additional low voltage control panel accessories including:
  - "NORMAL-OFF-TEST" circuit
  - receptacle for external test power supply
  - set of control circuit terminal blocks
- 2-high structure design for two complete motor controllers
- Available in optional ArcShield enclosure
- Also available as "Prepared Space" (Bulletin 1512BP) and Starter Kits (Bulletin 1512BS)

Specifications

Starter Size	Maximum Horsepower						Approximate Dimensions Inches (mm)			Approximate Weight lb (kg)
	2400V	3300V	4160V	4800V	6600V	6900V	Width	Depth	Height	
200A	800	1000	1250	1500	2250	2500	36 (915)	36 (915)	91 (2315) ❶	1770 (802) ❷
400A	1500	2250	2750	3000	4000	4000	36 (915)	36 (915)	91 (2315) ❶	1770 (802) ❷

❶ Height is 128.5 inches (3264 mm) with ArcShield enclosure with plenum.
❷ Weight will be different with ArcShield.

Power Circuit Schematic – 1512B



Medium Voltage Controller – Full Voltage Transformer Feeder Unit (Two-High) Starter

400 Amp

Description of Features

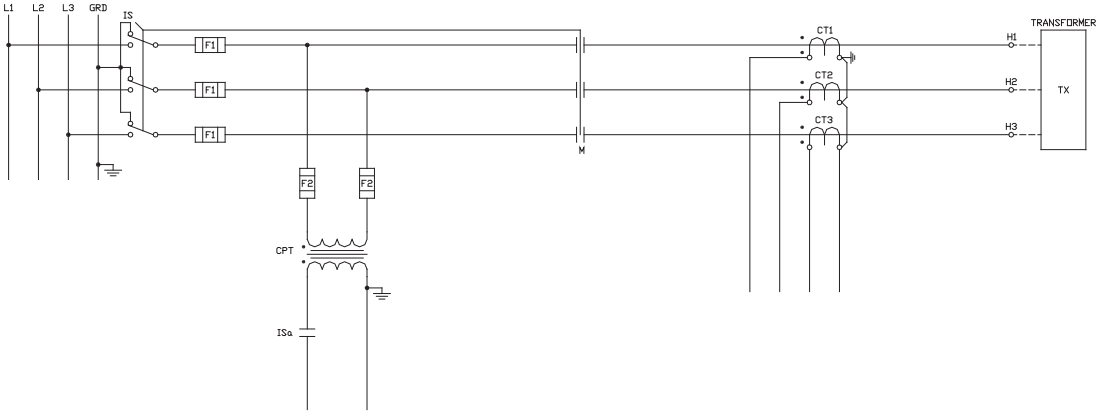
- Fixed mounted vacuum contactor
- Three-pole, gang-operated, non-load break isolating switch with an external operating handle, fully interlocked with main contactor and power cell doors
- A polycarbonate viewing window in the power cell door to view the position of the isolating switch
- Three (3) E-rated current-limiting power fuses
- Three (3) current transformers
- Control power transformer with primary and secondary fuses
- Segregated low voltage panel to house standard and optional hardware for unit control and monitoring
- IntelliVAC™ control module for each vacuum contactor, mounted in low voltage panel, with advanced features:
- Additional low voltage control panel accessories including:
  - "NORMAL-OFF-TEST" circuit
  - receptacle for external test power supply
  - set of control circuit terminal blocks
- 2-high structure design for two complete transformer controllers
- Available in optional ArcShield enclosure
- Also available as "Prepared Space" (Bulletin 1512BP) or Starter Kit (Bulletin 1512BU)

Specifications

Starter Size	Transformer Size (kvA)						Approximate Dimensions Inches (mm)			Approximate Weight lb (kg)
	2400V	3300V	4160V	4800V	6600V	6900V	Width	Depth	Height	
200A	700	1000	1250	1250	2000	2000	36 (915)	36 (915)	91 (2315) ❶	1770 (802) ❷
400A	1500	2000	2500	2750	N/A	N/A	36 (915)	36 (915)	91 (2315) ❶	1770 (802) ❷

❶ Height is 128.5 inches (3264 mm) with ArcShield enclosure with plenum.
❷ Weight will be different with ArcShield.

Power Circuit Schematic – 1512BT



Medium Voltage Feeders – Fused and Non-Fused Load-Break Switch

Description of Features

- Main load break switch for switching primary power source
- Feeder load break switch for switching other loads
- Isolation between upper and lower power cells
- The operating handle is fully interlocked with the power cell door
- Provisions on the operating handle for key interlocking
- A polycarbonate viewing window in the power cell door to view the position of the isolation handle
- Protective guard over the line terminals, inside the power cell, to barrier off medium voltage when the power door is open
- Feeders for 2-high structures
- Bulletin 1592BF – fused load break switch, designed as a feeder for 2-high structures
- Bulletin 1592F/M – fused load break switch, designed for feeder and mains
- Bulletin 1594F/M – non-fused load break switch, designed for feeder and mains

Specifications – 1592BF ❶

Starter Size	Transformer Size (kVA)						Approximate Dimensions Inches (mm)			Approximate Weight lb (kg)
	2400V	3300V	4160V	4800V	6600V	6900V	Width	Depth	Height	
200A	700	1000	1250	1250	2000	2000	36 (915)	36 (915)	91 (2315)	1770 (804) ❷
400A	1500	2000	2500	2750	N/A	N/A	36 (915)	36 (915)	91 (2315)	1770 (804)

❶ One 1592BF occupies half of a two-high structure.
❷ Includes complete two-high structure weight with two 1592BF units.

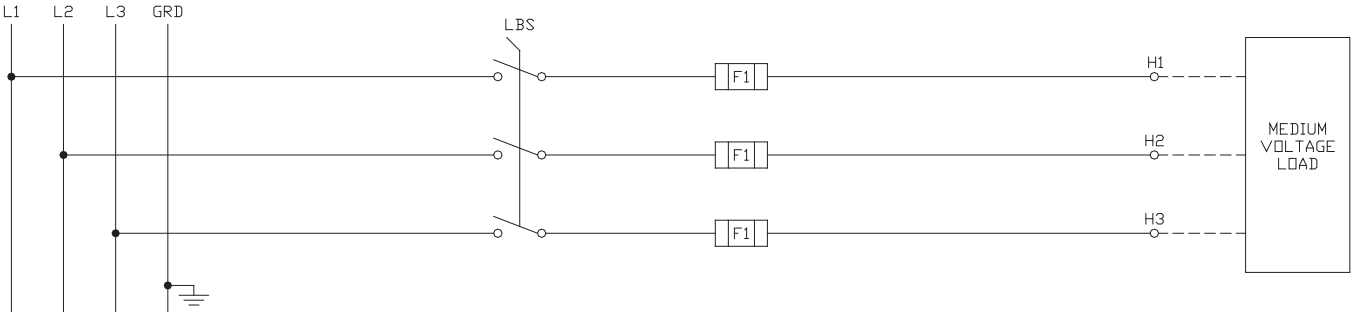
Specifications – 1592F/M / 1594F/M

Switch Size	Maximum Switch Size						Approximate Dimensions Inches (mm)			Approximate Weight lb (kg)
	2400V	3300V	4160V	4800V	6600V	6900V	Width	Depth	Height	
600A	❺	❺	❺	❺	❺	❺	36 (915) ❸	36 (915)	91 (2315)	1770 (804)
1200A	❺	❺	❺	❺	N/A	N/A	54 (1372) ❹	42 (1067)	91 (2315)	2500 (1135)

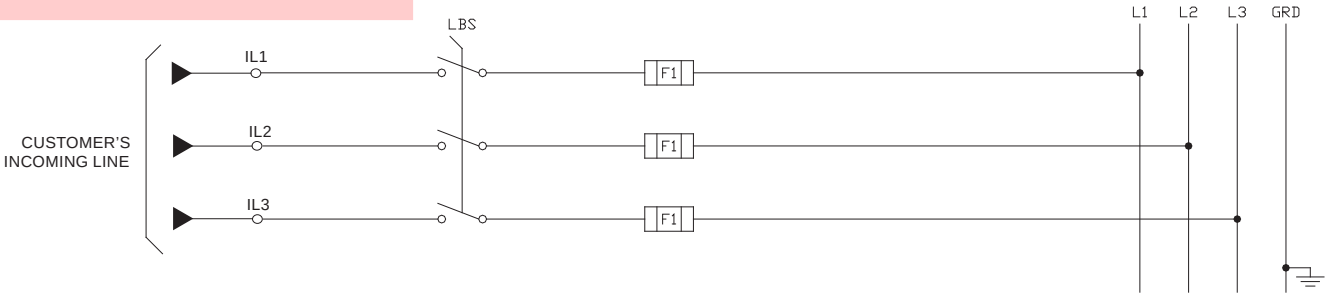
❸ If an isolated low voltage panel is required, the width increases by 18 inches (272 mm) and weight increases accordingly.
❹ If an isolated low voltage panel is required or incoming cables are fed from the bottom, the width increases by 18 inches (272 mm) and the weight increases accordingly. If the 42-inch deep unit is positioned on either end of 36-inch (94 mm) deep structures, the width increases by an additional 4 inches (104 mm).
❺ Available in all sizes except 1200A at 6600V and 6900V.

Medium Voltage Feeders – Fused and Non-fused Load-break Switch

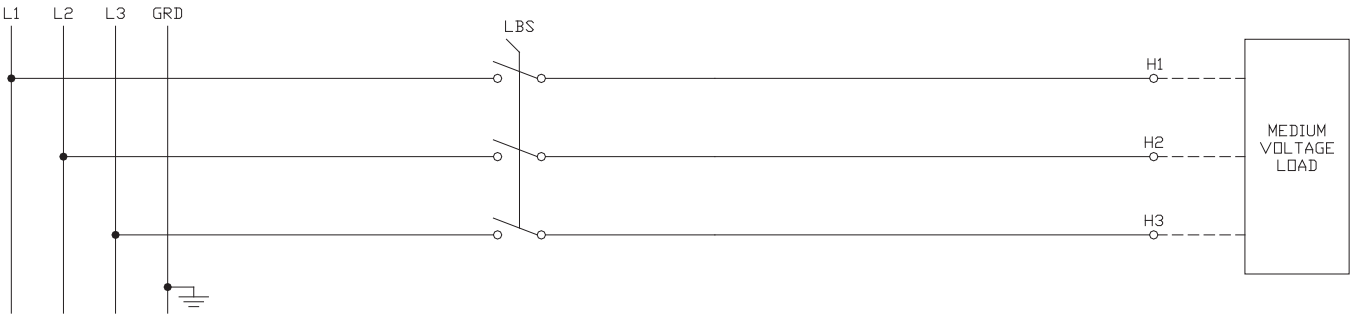
Power Circuit Schematic – 1592BF/F



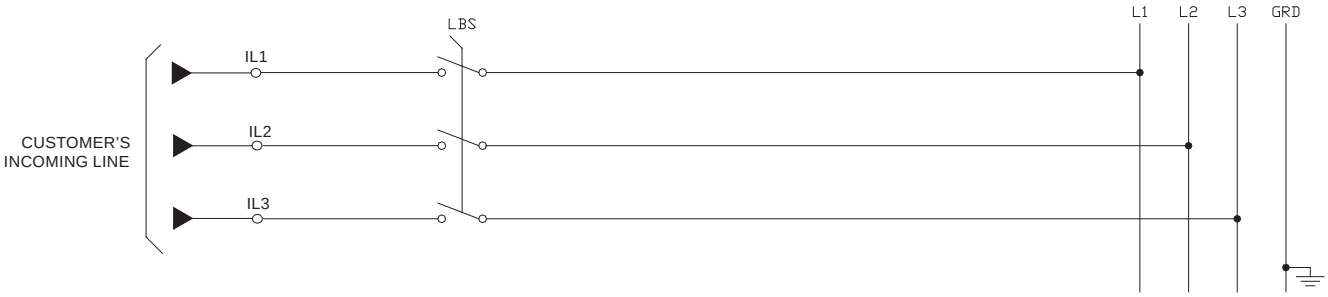
Power Circuit Schematic – 1592M



Power Circuit Schematic – 1594F



Power Circuit Schematic – 1594M



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Medium Voltage Motor Controllers

Allen-Bradley

Bulletin 1500/1900

Specification Guide

Important User Information

Solid-state equipment has operational characteristics differing from those of electro-mechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid-State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at **http://literature.rockwellautomation.com** describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for any indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequences.
SHOCK HAZARD	Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures.

CENTERLINE is a registered trademark of Rockwell Automation, Inc.

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1.0 General

Introduction

Rockwell Automation has produced quality medium voltage products to meet the requirements of all types of industries for well over six decades.

From the original oil-immersed contactor, to air break and vacuum contactors, to solid-state controllers such as Smart Motor Controllers and AC Variable Frequency Drives, Rockwell Automation has developed and built a medium voltage product line that satisfies those industries demanding greater safety, less maintenance, longer life and reliability in motor control equipment.

Added to those demands is the need for smaller and more flexible medium voltage products that are more efficient and that enable a reduction in building and expansion costs. The Allen-Bradley CENTERLINE® family of medium voltage controllers are available for system voltage ratings from 2400 to 6900 volts, and can be applied to motors ranging in size from 75 kW (100 hp) to 7,500 kW (10,000 hp).

At Rockwell Automation, we know that there is more to being a world-class supplier than just having the right product. That is why we have developed a variety of flexible delivery programs. If speed is critical to your selection, our ezShip delivery program may be just what you require. The ezShip program offers a variety of controllers, options and accessories to choose from.

Overview of CENTERLINE MV Controller Features

Low Voltage Compartment

Control Panel

- Provision is made to connect external control power during TEST mode
- Allows testing and troubleshooting of the power cell without exposing personnel to medium voltage
- Prevents backfeeding medium voltage through the control power transformer

Isolated Compartments

- All low voltage components are located in the low voltage panel
- Low voltage panel interior painted white for better visibility
- Power cell, low voltage panel, and bus compartment are isolated from each other for improved safety

1.0 General

Overview of CENTERLINE MV Control Features (cont.)

Power Bus Compartment

CENTERLINE Bus Design

- Designed as an integral part of the structure
- Dissipates heat more efficiently
- Edge-to-edge configuration maximizes resistance to magnetic forces and minimizes moisture or dust collection
- Molded bus brace reduces maintenance and provides better distribution of forces during a fault
- Accessible without a ladder, for installation and maintenance
- Allows for incoming line cables to enter through the top or bottom of the compartment

Power Cell Compartment

Non-Load Break Isolation Switch

- Electrical and mechanical interlocks prevent the switch from opening or closing when the contactor is energized.
- Ensures normal operation only when the switch is fully closed.
- Allows for separate source testing when in the "OFF" position.
- Blades are grounded in the "OFF" position.

Visible Isolation

- When in the open position, a visible barrier isolates the power cell from the power bus compartment.
- Status of the isolation switch can be viewed through a window in the power cell door.

Handle and Interlock Mechanism

- Simple direct drive mechanism improves reliability and ensures superior operator safety.
- Mechanical interlock mechanism remains part of the enclosure to eliminate setup adjustment.
- Power cell door is interlocked with the handle mechanism to prevent the door from being opened when the cell is energized.

Isolated Cable Ducts

- Easy access for cable installation
- Ample room for stress cones
- Provides isolated load cable compartments between top and bottom power cells (two-high structures)

Features (cont.)

Power Cell Compartment (cont.)

Swing Out Low Voltage Panel

- Allows for easy access to install load cables
- Maximizes low voltage panel space

Current Transformers

- Bar-type current transformers are supplied as standard for overload protection and optional metering

Vacuum Contactors

Modular Construction

- Designed to be interchangeable with other contactors of the same rating and design series
- Horsepower rated devices are located elsewhere in the power cell, so the contactor does not limit unit ratings.
- Easily removed for maintenance and repair

Vacuum Bottles

- Designed to industry specifications
- Arcing confined inside vacuum bottle for ionized gas protection
- Mounted on the front of the contactor for visible inspection
- Contact wear indicators located on the bottle eliminates the need for special tools
- Excellent dielectric recovery provides high switching frequency (up to 600 operations per hour)

Long Electrical and Mechanical Life

- 1,000,000 electrical operations (400 A)
- 2,500,000 mechanical operations (400 A)

Low Current Chop

- No surge suppression required for most applications
- Reduces the chance of cable or motor insulation failure caused by voltage spikes

1.0 General (cont.)

Features (cont.)

Vacuum Contactors (cont.)

Fixed-Mounted Devices

- Fixed-mounted design eliminates the safety issues typically associated with drawout contactors
- Compact design of the contactor eliminates the need for it to be removed from the power cell
- No drawout stab-and-finger assemblies, which require routine maintenance

Enclosures

- Choice of NEMA (IP) environmental classification:
  - Type 1 (IP10)
  - Type 1 with gasket (IP21)
  - Type 12 (IP52)
  - Type 3R (IP34)
- Optional arc resistant design (tested to IEEE C37.20.7, Type 2 Accessibility)
  - During an arc flash, the ArcShield controller safely redirects the arc flash energy out the top of the unit and away from personnel. This level of protection is also maintained when the low voltage door is open for maintenance purposes.
- Standard lifting brackets (removable) to facilitate installation
- Paint Finishes:
  - Description: Hybrid epoxy powder paint
  - Color: ANSI 49 medium light grey (standard)
ANSI 61 light grey (optional)
  - Painting: Air-atomized electrostatic spray
Total paint thickness = .002” (0.051 mm) min.
- Optional arc resistant design (tested to IEEE C37.20.7, Type 2 Accessibility)
  - Bulletin 1512A/AT (200, 400/450, 600, 800 ❶ Amps)
  - Bulletin 1512B/BT (200 to 400 Amps)
  - Bulletin 1562E (refer to Publication 1560E-SR022_-EN-P)
  - Bulletin 1591A (18 and 36-inch incomer)

❶ Derating required for 800A units.

The medium voltage product line shall provide various starting methods and options:

Squirrel-Cage, Induction Motor Controllers	Bulletin Numbers
Full Voltage Reversing	1506
Full Voltage Non-Reversing	1512
Multi-Speed, Non-Reversing	1522
Solid-State Reduced Voltage	1562
Reduced Voltage Autotransformer, Non-Reversing	1572
Reduced Voltage Autotransformer, Reversing	1576
Reduced Voltage Reactor, Non-Reversing	1582

Brush and Brushless Synchronous Motor Controllers	
Full Voltage Non-Reversing ….	1912
Full Voltage, Reversing	1906

Miscellaneous Units	
Incoming Units ……	1591
Load Break Switches	1592/1594

Rockwell Automation also offers MV solid-state soft starters. Refer to Publication 1560E-SR022_-EN-P for details.

The following custom engineered units are available upon request (i.e. for wye delta, wound rotor applications, etc.):

Custom Engineered Units	
Static Exciters	1271
Multi-Speed, Reversing	1526
Part-Winding, Non-Reversing	1532
Part-Winding, Reversing	1536
Wye-Delta, Non-Reversing	1542
Wye-Delta, Reversing	1546
Reduced Voltage Reactor, Reversing	1586
Potential Transformer Disconnect	1596B
Corner Unit ……	1599CU
Synchronous Part-Winding, Non-Reversing	1932
Synchronous Part-Winding, Reversing	1936
Synchr. Reduced Voltage Autotransformer, Non-Reversing	1972
Synchr. Reduced Voltage Autotransformer, Reversing	1976
Synchronous Reduced Voltage Reactor, Non-Reversing	1982
Synchronous Reduced Voltage Reactor, Reversing	1986

2.0 Scope

This specification outlines the overall fabrication, performance and functional requirements for a medium voltage motor controller for use with polyphase motors. The complete controller shall meet the overall design requirements as specified herein.

The starter shall be _____ V, 3 phase, _____ hp or _____ kW rated, and used for the starting of _____ motors (induction, synchronous, wound rotor).

The controller shall be manufactured by a single vendor.

3.0 Codes and Standards

The Seller's equipment shall be designed, manufactured and tested to meet or exceed the applicable requirements of the latest standards published by the following organizations:

- Canadian Standards Association (CSA), *Industrial Control Equipment C22.2 No. 14*
- American National Standards Institute (ANSI), *Instrument Transformers C57.13*
- Institute of Electrical & Electronic Engineers (IEEE)
- National Electrical Code (NEC)
- Occupational Safety & Health Act (OSHA)
- Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)
- National Electrical Manufacturers Association (NEMA), *Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)*
- Underwriters Laboratories, Inc. (UL), *High Voltage Industrial Control Equipment 347*
- European Directives for Safety and EMC

Note: It shall be the responsibility of the user and/or installer to know and meet all local codes, standards, and OSHA requirements.

Environmental Conditions

The controller shall accept nominal plant power of 2400V, 3300V, 4200V, 6600V, 6900V, 4800V, 5500V or 7200V AC (±10%), 3 phase 50/60 Hz (± 3%).

The standard controller shall operate in an ambient temperature range of 0°C to 40°C (32°F to 104°F) with a relative humidity of up to 95% (non-condensing). Higher ambient temperature conditions are to be supported with factory assistance.

The equipment shall be capable of being stored in an environment with an ambient temperature range of -40°C to 85°C (-40°F to 185°F).

If storage temperature fluctuates or if humidity exceeds 85%, space heaters should be used to prevent condensation. The equipment should be stored in a heated building having adequate air circulation. **The equipment should never be stored outside**.

Rockwell Automation products are built using materials that comply with Class 1: Industrial Clean Air sulfur environments as defined in IEC Standard 60654-4 (Operating Conditions for Industrial-Process Measurement and Control Equipment), and G1 as defined in ISO-S71.04-1985 (Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants).

The equipment shall operate at altitudes from 0 to 1000 m (3,300 ft) above sea level, without derating. For applications above 1000 m (3,300 ft), the maximum current and Basic Impulse Levels (B.I.L.) of the controllers shall be derated, and vacuum contactors may be compensated for operation at the specified altitude (see page 48).

Seismic Qualifications

The controller can be provided such that it shall withstand certain horizontal and vertical accelerations (seismic zones 1, 2, 3 and 4) without overturning or lateral movement when bolted down (mounted) per the Seller’s recommended installation instructions.

Note: The seismic qualification does not indicate that the equipment will operate properly during or after a seismic event.

4.0 Obligations of Seller

Deviations

Any exceptions or deviations shall be defined in writing at the time of bid.

5.0 Drawings and Manuals

Information Drawings

Orders shall include a submittal of three (3) paper prints of the dimension drawing and electrical drawings (two for customer and one for Seller's local representative), at the time engineering is finalized. These drawings shall be suitable for photocopying.

Approval Drawings

If requested at the time of order entry, approval drawings shall be available at no charge. The approval submittal shall include (3) bond paper prints of the dimension drawing and electrical drawings supplied at the published lead time after order receipt by Seller. Submittal of approval drawings requires an additional _____ weeks. Approval drawings can be sent electronically via the Internet, as an alternative to sending them by mail.

Note: Seller shall allow the customer two (2) weeks to review the drawings. This period starts on the date that the drawings are shipped to customer and ends on the date that the drawings must be back to Seller. If drawings are returned earlier than two (2) weeks, then lead-time shall be adjusted accordingly.

Final Drawings and Manuals

Certified drawings, instruction and maintenance manuals (3 sets) shall be provided on CD and sent within 30 days of final product shipment. Final drawings shall be available in DXF format at no charge.

6.0 Spare Parts

Recommended spare parts list and prices shall be supplied with the bid. Also, the address of the manufacturer's closest parts stocking location to the user shall be provided on request.

Critical Spares

These spare parts are identified as being associated with long lead times and/or are critical to the unit's operation. They should be held in reserve by the customer to limit unforeseen downtime.

Maintenance Spares

These parts are identified as being required by customers to regularly perform scheduled maintenance on their equipment. They include, but are not limited to, consumable spares that are required to be exchanged during scheduled customer maintenance periods.

Seller shall assist in determining an appropriate level of spare parts in conjunction with the customer's bill of material (which may include circuit breakers, full voltage starters, load break switches and other auxiliary equipment) and the customer's current installed base.

On-site Inventory Agreement (Optional)

Seller shall offer an on-site inventory agreement, in which the Seller will stock (in the closest stocking location) and supply as needed, all spare parts required by the user. The user shall have a controlled/ immediate access to this inventory 365 days a year.

7.0 Quality Assurance

All inspection and testing procedures shall be developed and controlled under the guidelines of the seller's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.

All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

All sub-assemblies shall be inspected and/or tested for conformance to vendor's engineering and quality assurance specifications.

All printed circuit boards with active components shall be burned-in for a minimum of 2 hours at 65ºC (149°F).

7.0 Quality Assurance (cont.)

Standard Testing

The following tests shall be carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), European Standard (EN), and International Electrotechnical Commission (IEC).

Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.

A "HI-POT" dielectric withstand test shall be performed on all buswork and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product's nominal AC voltage.

Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.

Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.

Medium Voltage starters shall be inspected for the following:
- Electrical interlocking
- Motor protection and ground fault, if applicable

Physical Inspection

The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.

Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.

- Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
- Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
- Operation of isolation switch handle (if supplied) and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.

All bus and bus connections shall be checked for proper clearance, creepage, phasing and tightness (torque).

Factory Inspections (Optional)

Visual Inspection of Equipment

If requested, a review of the electrical and mechanical drawings for the purchased equipment will be done with the Application Engineer and/or Project Manager prior to commencing the inspection. Any questions or clarifications prior to commencing the *Factory Inspection* will be addressed at this time. The Rockwell Automation Application Engineer and/or Project Manager will also review what will occur during the *Factory Inspection*.

The *Factory Inspection* consists of a customer visit to the factory with the intent to view the customer specific equipment at various stages of building existing at time of the visit. There is no preparation of the equipment in any way for the inspection, and is a means to allow the customer to verify the progress of the order without any disruption to the manufacturing cycle. No power is applied during the factory inspection.

At the conclusion of the *Factory Inspection*, the customer will reconvene with the RA Application Engineer and/or Project Manager to discuss any concerns or issues that arose during the inspection. The Application Engineer and/or Project Manager will advise the customer at the earliest possible time with an outline of financial and/or schedule impact of the changes.

Please refer to the current Medium Voltage Price Book (publication 1500-PL030_-EN-P) for relative charges.

Witness Testing

A review of the electrical and mechanical drawings for the purchased equipment will be done with the Application Engineer and/or the Project Manager prior to commencement of the *Witness Test*. Any questions or clarifications will be addressed at this time. The Rockwell Automation Application Engineer and/or Project Manager will also review what will occur during the *Witness Test*.

The *Witness Test* will be broken down into two individual elements: equipment physical inspection and electrical inspections.

7.0 Quality Assurance (cont.)

Witness Testing (cont.)

Physical Inspection

The physical inspection will consist of the following items:

- Ensure all power and ground bus connecting hardware is present and labeled.
- Ensure correct engraving of Unit and Master nameplates.
- Equipment physical layout and dimensions verified against engineering documentation.
- All components are verified against engineering documentation to be present and correctly installed.
- Warning nameplates, isolation barriers and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.
- Verify operation of isolation switch handle and door interlocks.

Electrical Inspection

The electrical inspection will consist of the following items:

- A 'Hi-Pot' dielectric withstand test is performed on all bus work and power cables from phase-to-phase and phase-to-ground.
- Control power at the rated voltage is applied to the equipment, and a functional demonstration of customer purchased options and control devices is completed.
- Instruments, meters, protective devices and associated controls are functionally tested by applying the specified control signals, current and/or voltages.
- The operation of the vacuum contactor is demonstrated.
- DeviceNet or IntelliCENTER system operation, where applicable.
- **MV SMC Starters only**: Applying rated voltage to the equipment and connecting to a test motor in our Medium Voltage Test facility.
  - Motor control is functionally demonstrated by starting and stopping the test motor.
- **Synchronous Starters only**: Voltage is injected into the power circuit within the controller at the secondary, and operation is demonstrated using a resistive load.

NOTE: There will be no medium voltage applied and the testing will be conducted in the low voltage test bay for all products except the MV SMC Starters.

At the conclusion of the Witness Test, the customer will reconvene with the RA Application Engineer or Project Manager to discuss any concerns or issues that arose during the test. The Application Engineer and/or Project Manager will advise the customer at the earliest possible time with an outline of financial and/or schedule impact of any changes identified during the witness test.

Please refer to the current Medium Voltage Price Book (publication 1500-PL030_-EN-P) for relative charges.

Custom Testing

The customer specifications for the customer test must be provided to Rockwell Automation at least two months prior to testing date, at which time Rockwell Automation will provide a cost and schedule impact for completing the testing requirements. This test will be priced on a per project basis, based on the scope of the test and location.

8.0 Equipment Design and Selection

Structure and Controller

The medium voltage motor controllers shall consist of a single structure or a line-up of structures containing the following:

- An isolated compartment for horizontal power and ground bus
- A terminal provision to feed the bus
- Removable backplates
- An allowance for top or bottom entry of the power and/or control cables (top entry may not be possible with arc resistant option)
- An allowance for top or bottom exit of the load cables from the controller through isolated metal wireway(s) (top exit may not be possible with arc resistant option)
- Viewing window in the power cell door
- Removable lifting angles or brackets
- Non-removable sill channels
- Paint Finishes:
  - Description: Hybrid epoxy powder paint
  - Color: ANSI 49 medium light grey (standard)
    ANSI 61 light grey (optional)
  - Painting: Air-atomized electrostatic spray
    Total paint thickness = .002” (0.051 mm) min.
- Appropriate starter units to meet the application requirements

The motor control center(s) (MCC) shall have provisions to enable them to be bolted together to form a rigid, free-standing assembly, and shall be designed to permit bus extension for future controller additions to the left and/or the right.

Each structure shall have two (2) non-removable base sill channels and removable lifting angles or brackets for ease of handling and installation.

The medium voltage controllers shall be designed in two basic styles:

- 1-High: One (1) medium voltage controller in one (1) vertical section
- 2-High: Two (2) medium voltage controllers in one (1) vertical section

The structure shall be divided into three (3) isolated compartments:

- Main power and ground bus compartment
- Power cell compartment
- Low voltage compartment

Metal or insulating barriers shall be provided between each vertical section, between the low voltage compartment and the power cell and/or main power bus compartment, and between the power cell and main power bus compartment. Personnel shall have access to the low voltage compartment, with the controller energized, without being exposed to any medium voltage.

The medium voltage motor controllers shall be for 3-phase, 3-wire, 50/60 Hz applications, rated 2400, 3300, 4160, 4800, 5500, 6600, 6900 or 7200 volts.

The medium voltage motor controller shall consist of a metal-enclosed, free-standing, dead front, vertical steel structure. Each structure shall contain the following items:

- Tin-plated copper horizontal power bus (optional)
- A continuous bare copper ground bus
- A main non-load break isolating switch and operating handle
- Vacuum contactor(s)
- Three (3) current limiting power fuses for NEMA Class E2 operation
- Three (3) current transformers
- A control power transformer
- A low voltage control panel
- Space for necessary auxiliary control and metering devices
- Top and bottom plates to accommodate cable entry/exit

Enclosure Types

The medium voltage product line shall be available in a NEMA Type 1 (IEC IP10) general purpose enclosure as standard. Optional enclosures are NEMA Type 1 with door gasketing (IEC IP21), NEMA Type 12 dust tight and drip proof (IEC IP52) or NEMA Type 3R outdoor (IEC IP34) non-walk-in styles. Each enclosure shall be properly sized to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions.

Arc Resistant Enclosure (optional)

The medium voltage motor controller(s) shall be provided with an arc resistant enclosure design (select units – consult factory for availability).

The arc resistant units will meet the requirements per IEEE C37.20.7™, Type 2 Accessibility, and provide the following benefits:

- Reinforced structure, to contain arc flash material, at faults up to 40 kA, 0.5 seconds
- Arc vent to exhaust arc flash material
- Plenum or chimney to redirect arc flash material
- Reinforced low voltage panel, sealed to prevent entry of arc flash material

8.0 Equipment Design and Selection (cont.)

Structure and Controller (cont.)

Structure Finish

As standard, all exterior and interior metal parts (except for the power cell back plates and low voltage panel) shall be painted ANSI 49 medium light gray (3R shall be ANSI 61). All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility. Optional field touch-up spray can(s), matching the enclosure color, shall be supplied when requested.

Description	Hybrid epoxy powder paint
Standard color	ANSI 49 medium light gray (optional ANSI 61 light gray)
Procedure.....	Continuous paint line. All parts are painted before assembly.
Preparation	Alkaline wash/rinse/iron phosphate rinse/iron-chrome sealer rinse/recirculated de-ionized water rinse and virgin de-ionized water rinse.
Painting	Air-atomized electrostatic spray. Total paint thickness - 0.002” (0.051 mm) minimum
Baking	Natural gas oven at 179°C (355°F) minimum.

Notes:

1. When optional custom paint color is specified (including ANSI 61), all external surfaces shall be painted to the custom color requirement, except for the external isolating switch handle assembly, lifting angles and lifting brackets.
2. All unpainted steel parts shall be plated for corrosion resistance.

Power Bus

Horizontal Bus

The main horizontal power bus shall be located at the center rear of the structure, to provide optimum heat distribution, ease of maintenance and splicing. The power bus shall be mounted on the edge to a molded bus support insulator in a common vertical plane. This mounting method provides superior short-circuit withstand capability and protection against the accumulation of dust and tracking between phases. The power bus shall be made of tin-plated copper and be available in one of the following continuous current ratings: 1200, 2000 or 3000 amps. Optional silver-plated power bus shall be available.

Access shall be provided to the bus compartment from the front or the rear of the structure to allow for installation and regular maintenance of the power and ground bus splice connections.

When optional insulated power bus is specified for the main horizontal bus, a sleeve-type, heat shrink insulating material with good flame resistance and self-extinguishing properties shall be used. This material shall have a minimum wall thickness of 1.4 mm (0.055 in.), and provide a minimum dielectric strength of 49.5 kV.

Vertical Bus

Vertical power bus risers shall be provided from the main horizontal power bus to the unit isolating switch line terminals. It shall be made of tin-plated copper and rated according to the unit size.

Bus and Cable Bracing

The horizontal/vertical bus work and the cabling/bus in the main power cell(s) shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347.

The bus work and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short-circuit fault.

Ground Bus

A continuous bare copper ground bus shall be provided along the entire length of the controller lineup. A mechanical lug for #8 - #1/0 AWG or #6 - 250 MCM cable shall be supplied at the incoming end of the lineup. The standard ground bus shall be 6 x 52 mm (1/4 in. x 2 in.) bare copper. Optional tin plating shall be available.

8.0 Equipment Design and Selection (cont.)

Main Isolating Switch

The main power cell shall have an externally operated, 3-pole, gang operated, fixed mounted, non-load break isolating switch providing the following features:

- The isolating switch shall isolate the power bus compartment from the power cell by means of a positively driven shutter mechanism to prevent accidental contact with line terminals in the power bus compartment.
- The main power cell door shall have a viewing window through which the operator can verify that the isolating switch is open.
- The isolating switch shall only have the ability to interrupt the no-load (magnetizing) current of the control power transformer(s) (CPT) and/or potential transformers (PT) supplied inside the controller power cell.
- In the OFF position, the isolating switch shall provide a means of grounding appropriate medium voltage power cell components, discharging stored energy, thus providing safer operation and maintenance.
- Three rating sizes shall be available: 400 amp, 600 amp, 800 amp.
- One or more N-O and N-C auxiliary contacts shall be arranged to open the secondary circuit of the CPT and/or PT, de-energizing the control circuit. This is to ensure there is no load on the isolating switch when it is opened or closed. The contacts shall also prevent backfeeding through the CPT and/or PT, and isolate the power cell when the control circuit is in the TEST mode. It shall only be possible to operate the TEST control circuit when the isolating switch is in the open position. The auxiliary contacts shall have a NEMA contact ratings of 2 x A600 and 2 x P600.
- The isolating switch shall remain connected to the external operating handle at all times.
- The isolating switch shall also be mechanically and electrically interlocked with the main contactor(s).
- The external isolating switch operating handle shall have provisions to be padlocked, with up to three (3) padlocks in the open position, and one (1) padlock in the closed position. The closed position shall be located and marked, but shall be drilled out by the USER to allow insertion of the padlock.
- The power cell door on each controller shall be interlocked with the isolating switch such that the door(s) cannot be opened when the isolating switch is fully closed, and the isolating switch cannot be closed with the door(s) open (without circumventing the interlock using a tool).

Interlocking

Mechanical interlocking, including cable interlocks, horizontal and vertical ram interlocks, shall be provided to prevent the opening of any power cell door or medium voltage compartment until the non-load-break isolating switch is fully in the open position and power is removed (the external operating handle must be in the "OFF" position).

Optional key interlocks, configured to operate with the operating handle or power cell door, shall be available when interlocking is required with another specified device, i.e. main breaker, load-break switch, starter, etc.

Power Fuses and Fuse Holders

Depending on the type of load, R-rated or E-rated current limiting power fuses shall be provided. R-rated fuses shall be used for the short-circuit protection of medium voltage motors and motor controllers. E-rated fuses are general purpose fuses and shall be used in combination with an overload relay, under certain conditions, for the short-circuit protection of non-motor loads (when possible), i.e. primary protection of power transformers.

The medium voltage controller shall have fixed power fuse holders that are separately mounted in the power cell, not on the contactor, and be located to allow easy inspection and replacement without any disassembly. The power fuses shall provide visual condition indication by way of a spring-actuated blown fuse indicator. The power fuse size shall be selected when motor data and the protective device characteristics are known.

Vacuum Contactor Specifications

The electrically (magnetically) held or mechanically latched (optional) style medium voltage contactor shall be the Allen-Bradley Bulletin 1502 vacuum type.

The following current ratings shall be available:

- 400 amp
- 800 amp

The contactor shall have visual contact wear indicators. No special tools are required for checking contact wear.

Vacuum bottles and coil maintenance shall be facilitated while the contactor is mounted within a power cell. Removal of contactor is not required.

8.0 Equipment Design and Selection (cont.)

Vacuum Contactor Specifications (cont.)

The contactor shall be fixed mounted inside the power cell. Fixed mounting provides solid, continuous contact while lowering maintenance requirements considerably. The contactor shall be interlocked with the non-load-break isolating switch, both electrically and mechanically, which shall provide the following safety features:

- Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
- Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
- Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
- Remove control power from the CPT, PT or external power source to the control circuit when the isolating switch and contactor are in the open position.

Control Wire Specifications

The control wire shall be insulated (with a flame retarding thermoplastic compound), flexible, stranded, tinned copper wire supported and neatly bundled. Red wire shall indicate AC control, blue wire shall indicate DC control, and green wire shall indicate ground. Other colors or combinations may be used for specific applications. The control wire shall be isolated from high voltage components in the power cell (whenever possible), and wire markers which are numbered according to the electrical diagram, shall be provided at each end of the wire.

All of the control wire terminations shall be a screw-type, tin-plated copper compression-type terminal block or connector which firmly grips the conductor. Non-insulated, locking-type, fork tongue lugs shall be provided on the control wire terminating on the control power transformer(s) and current transformers.

Low Voltage Wireway

An optional low voltage wireway shall be available across the roof of the structure. There are two (2) sizes of low voltage wireway available:

- 51 mm x 102 mm (2 in. x 4 in.)
- 152 mm x 152 mm (6 in. x 6 in.)

The low voltage wireway shall allow a convenient method of interconnecting control wire from one controller to another, when interfacing with a master panel or with programmable controller circuits.

Low Voltage Control Panel

Each controller shall have a separate, front accessible, low voltage control compartment. The compartment shall be completely isolated, using metal barriers between the low voltage compartment and the power cell and/or main power bus compartments for utmost safety.

Optional meters, protection relays, selector switches, operators, indicating lights, etc., shall be mounted on the front of the low voltage control panel, and arranged in a logical and symmetrical manner. The low voltage panel shall provide the following features:

- Space shall be provided for low voltage control devices, transducers and metering.
- Necessary terminal blocks shall be supplied. Extra terminal blocks can be supplied as an option.
- There shall be low voltage control panel access from the front without turning the controller OFF.
- All remote low voltage cables shall be able to enter the low voltage control panel from the top or bottom of the structure. Access shall be by means of removable entry plates on the top and bottom of the structure.
- Some controllers shall incorporate a swing-out low voltage panel which provides easier access to the power cell to make bus splicing and load cable connections. When present, the swing-out low voltage panel shall be interlocked with the power cell compartment (the panel shall not have the ability to swing open until the power cell is OFF and isolated from the main power bus).
- The control panel supply voltage shall be 120 or 230 VAC, 50/60 Hz (as specified at time of order).
- There shall be a two-pole, three-conductor (with a grounding prong) male plug to provide a means of connecting a two-pole, three-conductor receptacle from a remote 120 V AC, 60 Hz supply to operate the control circuit when it is in the TEST position.

8.0 Equipment Design and Selection (cont.)

Low Voltage Control Panel (cont.)

- IntelliVAC contactor control shall be used as standard, with the following features:
  - Universal input voltage range (110-240 V AC, 50/60 Hz or 110-250 VDC)
  - Consistent vacuum contactor pick-up time, ensuring optimal synchronization
  - Selectable and repeatable vacuum contactor drop-out times (50, 75, 100, 130, 150, 175, 200 or 240 msec) for tighter coordination with power fuses
  - Altitude compensation (-1,000 to 5,000 meters) to eliminate mechanical hardware changes at high altitude (400 Amp vacuum contactors)
  - Power loss ride-through (TDUV) with selectable drop out time (0.2, 0.5, 1.0 or 2.0 sec.)
  - Anti-kiss and anti-plugging protection
  - Status indication (LEDs and relay outputs) allows integration in control system and aids troubleshooting
  - Temporary motor jog function (separate input) to allow process set-up
  - Delayed motor re-start prevents rapid cycling of vacuum contactor, protecting the connected motor and avoiding nuisance clearing of power fuses
  - Capable of field upgrade to either IntelliVAC Plus or IntelliVAC MC (if desired)

- IntelliVAC Plus contactor control shall be available as an option, building on the capabilities of IntelliVAC with the following additional features:
  - DeviceNet communication
  - DeviceLogix control
  - Digital inputs (8) rated for 110 to 250 VAC or VDC, and outputs (2) rated up to 250 VAC or VDC, all with LEDs indicating status
  - Support for multi-contactor (MC) control schemes, with up to four slave IntelliVAC MC units connected on RS485, and DeviceLogix pre-configured for standard MV controller logic (can also define Custom MC control configurations)
  - Enhanced operational information and diagnostics with features like real-time clock, extended contactor close time monitoring and tracking of contactor usage
  - IntelliCENTER software compatibility
  - Configurable using either RS Networx or handheld configuration terminal (Bulletin 193-DNCT) for DeviceNet

- IntelliVAC MC contactor control shall be available as an option, for use in multi-contactor applications (one IntelliVAC Plus can control up to four IntelliVAC MC control modules in a Master-Slave configuration), with the following features incremental to IntelliVAC:
  – Communication board (with RS485) to allow IntelliVAC MC to be controlled by IntelliVAC Plus
  – Address indication (7 segment LED) for RS485

Electromechanical Relay Control (Optional)

- Control panel complete with pilot control relays and DC economizing circuit to control the vacuum contactor.

8.0 Equipment Design and Selection (cont.)

DeviceNet and IntelliCENTER Options

General

The MV motor controller (MV MCC) shall have DeviceNet cabling integrated throughout the sections.

Each Motor Starter and Soft Starter in the MV MCC line-up shall be supplied with a means to communicate via DeviceNet, and have the capability of monitoring at least 2 devices in each starter.

DeviceNet Cable

The DeviceNet cable used for the trunk line and drop lines shall be *flat* cable rated 8 amperes, 600V, Class 1.

The DeviceNet cable used to connect a DeviceNet unit to a DeviceNet port shall be round cable rated 8 amperes, 600V, Class 1.

The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

DeviceNet Cable Layout

A DeviceNet trunkline shall be routed through the low voltage wireway, located on the top of each MV MCC section to prevent accidental mechanical damage during MV MCC installation.

A DeviceNet dropline shall be routed into the low voltage control panel of each MV MCC unit.

Two (2) DeviceNet ports shall be provided in the low voltage control panel of each unit to simplify installation of DeviceNet products.

Power Supplies

The MV MCC manufacturer shall check the user's design to ensure adequate power supplies have been specified to conform to DeviceNet requirements. The power supply shall provide 24Vdc for the DeviceNet system and be rated no less than 8.0 amperes.

DeviceNet System Performance

The DeviceNet system shall be designed to operate at 500k Baud to maximize the system performance, unless precluded by the cumulative length of the trunk and drop lines.

The DeviceNet system is to be qualified to communicate and perform under normal and adverse MV MCC electrical environments, e.g. vacuum contactor electrical operation and unit short circuit fault.

Unit Monitoring

Each unit shall be supplied with IntelliVAC Plus for vacuum contactor control and unit monitoring. The eight (8) digital inputs shall be used to monitor the status of the isolation switch as well as other non-intelligent devices. The two (2) digital outputs are available for use in the control system (customer to program and additional control hardware).

Solid-State Controllers

Each solid-state controller (SMC Flex) unit shall have a DeviceNet communication module to communicate the status over DeviceNet.

Unit Protection

Available options for protection include:

- 825P modular
- E3 Plus
- E1 (equipped with optional DeviceNet module)

Programming of Parameters

The DeviceNet MAC ID number (node address) shall be loaded into each unit per the drawings. All other parameters shall be left at the factory default setting.

The DeviceNet System components shall be preconfigured to operate at the appropriate baud rate.

8.0 Equipment Design and Selection (cont.)

Software

The DeviceNet MV MCC shall be provided with pre-configured software. The software shall be capable of viewing multiple MV MCC line-ups. The software communication driver shall allow the software to be installed and located on Ethernet, ControlNet, or DeviceNet. The software shall be capable of displaying the following:

- *Unit Monitor View*
  - Dynamically configured based on reading data from devices in MV MCC line-up
  - Sizeable view to allow ease of viewing multiple MV MCC line-ups
  - Unit nameplate information
  - Unit status indicators (ready, running, warning, fault, no communication)
- *Unit Monitor View*
  - Pre-configured for specific unit
  - Real time monitoring via analog dials and trending
  - Data configurable for customized monitoring
  - Modifying device parameters
- *Speadsheet View*
  - User configurable for customized monitoring
  - Sorting and cascading functions
  - Custom user fields
- *Event Log*
  - Track history of MV MCC unit
  - Automatic logging of trips, alarms, and changes
  - Manual entry of events
- *Documentation*
  - Front elevation drawings
  - One-line drawings
  - Unit wiring diagrams
  - User manuals
  - Spare parts lists

Testing

The interwired DeviceNet MV MCC shall be powered up, configured and tested in an ISO9001 facility to ensure each unit communicates properly prior to shipment.

Control Power Transformer

The control power shall be 110/120 or 220/240 V AC, and shall be obtained from a control power transformer (CPT) located in each controller power cell, or from a separate control source. As standard, the dry-type CPT shall be 500 VA in size, with approximately 350 VA extra capacity for the customer's use when the standard control circuit is supplied. Appropriately sized primary and secondary fuses will be supplied. Optional sizes of 1000 VA, 2000 VA and 3000 VA control power transformers shall also be available.

The secondary circuit of the transformer(s) shall be disconnected from the control circuit by means of the isolating switch auxiliary contacts. This is to prevent backfeeding through the transformer(s) and to isolate the power cell when the control circuit is in the "TEST" mode.

The standard control power transformers used in the controller shall be a compensated type with an output accuracy of approximately 4% over nominal at no load. They shall be designed to maintain voltage at in-rushes of up to 600%, which results in a 2% over-voltage at full load.

Notes:

1. The control power transformers may be used for metering, ONLY IF the accuracy of the application does not require conformance to any potential transformer accuracy ratings.

2. The maximum quantity/size of the CPT(s) available in a two-high FVNR controller rated 7200 volts is (2) - 500 VA (with bolt-on power fuses), or (1) - 1000 VA and (1) 500 VA (with clip-on power fuses).

Primary Fuses

The primary side of the control power transformers and/or potential transformers shall be protected by current limiting fuses sized according to requirements. The interrupting rating of the primary fuses shall be 50 kA symmetrical.

Secondary Fuses

The secondary side of the control power transformer and/or potential transformers shall be fused appropriately to protect the transformer(s) from overloads. The standard control circuit shall have one leg of the secondary grounded.

8.0 Equipment Design and Selection (cont.)

Current Transformer

The medium voltage power cell shall include three (3) current transformers of sufficient VA capacity to meet the requirements of all the devices connected to them.

Each current transformer shall have the primary rating sized appropriately in relation to the full load current rating of the motor or feeder. The secondary of the current transformers shall have a five amp (5 A) output and an accuracy suitable for the type and quantity of protection or metering devices connected to it. All current transformer control wiring shall be terminated on the current transformer with locking-type, fork tongue lugs.

An appropriate load termination location shall be provided to accommodate lugs with single or two-hole mounting, for connection of the load cables, when either bar or donut-type current transformers are supplied.

The power cell shall have provisions to locate a toroid (donut) style, ground fault sensing current transformer, when the optional zero sequence ground fault protection feature is required.

Power Wire Specification

As standard, the power cell shall be wired with the appropriate size of power wire based on the controller current rating. Power wire shall be rated for 8.0 kV, regardless of the unit rating.

Motor Protection Devices

For each starter unit, a Bulletin 592 thermal electromechanical, E1 Plus, E3/E3 Plus, or Bulletin 825P solid-state motor protection overload relay shall be supplied. The overload protection relay shall be connected to the secondary of the three (3) current transformers.

Note: Alternate motor protection relays shall also be made available.

Undervoltage Protection

Optional undervoltage protection devices or circuits serve to protect the motor by not permitting the starter to remain energized in an undervoltage condition.

Instantaneous undervoltage protection is supplied as standard. The IntelliVAC can be configured to provide time delay undervoltage (TDUV) protection. This feature is available to keep electrically held contactors closed during a voltage dip or brief power loss. If the undervoltage condition persists beyond the set delay time, the contactor will be opened and an undervoltage fault condition will occur.

Synchronous Control (Brush-Type)

Synchronous exciter (optional) shall be sized based on motor information. The table in Section 11outlines the exciter sizing and SCR bridge output capability details.

- The assembly shall be either three phase or single phase depending on the output current requirements.
  – It shall have an integral single- or three-phase firing board
- The bridge rectifier shall incorporate a solid state field switch mounted directly on the bridge assembly. This switch shall remove the discharge resistor connection at the appropriate time.
  – An integral field switch snubber assembly shall be provided to provide protection and diagnostics for proper operation of the solid state switch
- The exciter shall be regulated using a closed loop feedback from the DC field current. This provides a constant current based on the user setting.
  – A DC current transducer (DCCT) shall be used to measure current
  – A field current adjustment potentiometer shall be provided on the front of the door
  – A 3 ½" field DC ammeter shall be provided on the front of the door

Rectifier Transformer

- The rectifier transformer shall be integral to the controller.
- It shall be sized according the requirements of the field and rectifier bridge load
- The transformer shall be energized/de-energized by the main MV contactor
- The transformer shall have a minimum 25 kV BIL rating
- It shall be dry type.
- Appropriately sized primary and secondary fuse protection shall be provided.
- Main Power fuses for the motor controller shall not be used as the primary protection for the rectifier transformer.

8.0 Equipment Design and Selection (cont.)

Field Discharge Resistor

- The field discharge resistor shall be mounted internal to the main structures.
  - If the resistor is too large to be mounted internally, it shall be mounted on the roof of the structure in a protective enclosure.
  - If roof mounted the resistor and its enclosure shall be removed for shipment.
- The resistor will be sized based on the motor data provided by the user at the time of order placement.
- The resistor will be steel grid or wire edge wound type.

Field Application and Protection

The Bulletin 1902 SyncProII programmable field application and protection system shall be used for squirrel-cage, brush-type synchronous motors.

This system shall consist of a Rockwell Automation programmable small logic controller (MicroLogix™ 1200) with the following additional peripheral items:

- PanelView™ 300
- Phase Angle Transducer
- Analog/Digital Pulse Board
- Conditioning Resistors
- Interposing Relays FCR and ESR
- Specialized firmware for synchronous control and protection

This system must provide supervisory protection and field control to a brush-type synchronous motor controller, proper field application timing, squirrel-cage protection against long acceleration and stall conditions, as well as running pull-out protection by monitoring motor power factor. It shall provide the following:

Protection/Control to be provided by SyncProII

- Squirrel-cage winding protection
- Field winding application control
- Incomplete sequence
- Field voltage failure
- Auto load
- Stall protection
- Pull-out protection (power factor)
- Restart lockout

Display/Metering to be provided by SyncPro™II

The product in conjunction with the PanelView 300 Micro Terminal (PV) will perform the following metering/display functions:

- display all detected fault conditions
- display the slip frequency and starting time during startup
- display the power factor during run mode.
- accept set points for the following:
  - maximum % asynchronous speed [% of synchronous speed]
  - power factor set point and trip delay
  - maximum allowable time at stalled state (maximum slip)
  - maximum allowable time at 50% speed
  - maximum allowable time at synchronizing speed (typically at 95% speed)
  - function order (allows adjustment of the slope of the acceleration/stall time trip curve).
  - incomplete sequence timer trip delay
  - fault mask for PF transducer diagnostics

SyncPro™II Operating Power

- Input Line Voltage
  - between 115V/230V ±10%, 50 or 60 Hz
- Input Power Requirements
  - 5 VA
- Input Current
  - 0.2 and 10 Amps

8.0 Equipment Design and Selection (cont.)

Synchronous Control (Brushless Type)

- Exciter shall be sized based on motor information. The following table outlines the standard exciter sizing and output capacity details.

Voltage	Maximum Current
125V DC	10A
	20A

- The exciter shall be made up of:
  - A single phase bridge rectifier
  - A power rheostat (door mounted)
  - A 3 ½" DC ammeter
  - DC Application Contactor
  - Timing relay
  - Slip guard relay or Bulletin 825P modular protection system with voltage option card.
- The exciter shall be powered from the main control circuit transformer of the controller.
- Control Circuit Transformer size will be a minimum of 500VA

Prepared Spaces

When specified, a controller shall be factory constructed with a prepared space to enable the addition of a FVNR controller, or to complete a fused load-break switch feeder (200 or 400 amp) in the future, on site, using a starter/transformer kit or a load-break switch feeder kit. (Not available for arc resistant controller.)

Note: The two-high structure is the most common structure offering this prepared space feature. However, it shall also be available for the one-high, 400 amp FVNR structure.

Starter Prepared Spaces

When a prepared space (for a future controller) is ordered for a one or two-high structure, the following items shall be supplied:

- The main non-load break isolating switch and external operating handle. A mechanical interlock shall be installed to keep the switch in the open position (a label is included with each prepared space to indicate this).
- The electrical and mechanical interlocks, including the contactor interlock rod assembly and hardware.
- Appropriate barriers and wire duct for load cables.
- The power cell door with door screws and viewing window. The anodized clip on the power cell that interlocks with the operating handle is removed. This prevents the switch from closing whether the power cell door is open or closed.
- A blank low voltage door.

8.0 Equipment Design and Selection (cont.)

Prepared Spaces (cont.)

Load-Break Switch Prepared Spaces

When a prepared space for a fused load-break switch feeder is ordered for a 2-high structure, the following items shall be supplied:

- The 400 A load-break switch (shipped in the open position) including interphase barriers and Lexan cover connected to the external operating handle.

  Note: A mechanical interlock shall be installed to keep the switch in the open position (a label is included with each prepared space to indicate this).

- The top power fuse support assembly, less the fuse clips.

- Appropriate barriers and wire duct for load cables.

- The power cell door with door screws and viewing window. The anodized clip on the cell that interlocks with the operating handle is removed. This prevents the switch from closing whether the power cell door is open or closed.

Notes:

1. A circuit diagram shall be sent with each prepared space compartment.

2. No structural modifications shall be required when installing the starter kit or fused load-break switch feeder kit.

3. The prepared space shall be required when installing the starter kit or fused load-break switch feeder kit.

4. The prepared space shall be located in the top power cell when the load cables exit through the bottom of the structure.

5. Installation of starter kits into prepared space locations must be completed in compliance with NFPA-70E (or equal) guidelines.

Starter Kits

When a starter/transformer controller kit is ordered to convert a prepared space power cell into a functioning medium voltage controller for motor or transformer loads, the following parts shall be provided:

- The main power fuse clips, bottom fuse support, interphase barriers and main current limiting power fuses.
- The control power transformer including current limiting power fuses.
- The main current transformers complete with barrier plates and hardware for the mounting.
- All of the necessary power and control wiring.
- The low voltage door complete with optional controls, meters and wiring.
- The low voltage panel with the interconnecting control wiring, labels, relays and terminal blocks.
- The main vacuum contactor mounted on a base plate, allowing for easy installation in the power cell. The contactor shall include the mechanical interlocking plate, ready for connection of the interlock rod assembly.
- The anodized clip for the power cell door. This allows the external operating handle to work properly.
- Instructions and identification nameplates.

The power circuit to and from the vacuum contactor shall be connected in accordance with the circuit diagram provided with the starter kit.

8.0 Equipment Design and Selection (cont.)

Feeder Kits

When a feeder kit is ordered to convert a load-break switch prepared space power cell into a functioning medium voltage 400 A fused load-break switch, the following parts shall be provided:

- The main power fuse clips, bottom fuse support, interphase barriers and main current limiting power fuses.
- The control power transformer including current limiting power fuses.
- The load terminal assembly complete with mounting/barrier plates and hardware for the mounting.
- All of the necessary power and control wiring.
- The anodized clip for the power cell door. This allows the external operating handle to work properly.
- Instructions and identification nameplates.

9.0 Transportation and Equipment

Delivery Times

Estimated drawing and shipment delivery times are based on receipt of all information at time of order.

Shipment of equipment will commence approximately ____ weeks after the Seller receives a written purchase order. Actual on-site delivery will depend on the site location.

Unless specified, transportation is determined by the Seller based on shipment by the lowest cost carrier, and charged to Buyer.

Loading Equipment

As standard the Seller must utilize tractors and trailers equipped with air-ride features, reducing the chance of damage and the need for extra packaging. All trailers shall have logistic posts allowing the most secure loading.

Special Packaging Requirements (Optional)

The Seller must use custom-designed crates to reduce the possibility of air or sea transit damage, and offer vacuum shrink-wrap to eliminate moisture or humidity damages.

10.0 Commissioning

Start-Up Commissioning Services (Optional)

Start-up will be performed at the User's site.

The Seller will provide the following:

- A pre-installation meeting with the User to review:
  – The start-up plan
  – The start-up schedule
  – The controller’s installation requirements
- Inspect the controller’s mechanical and electrical devices enclosed
- Perform a tug test on all internal connections within the controller and verify wiring.
- Verify critical mechanical connections for proper torque requirements.
- Verify and adjust mechanical interlocks for permanent location.
- Confirm all sectional wiring is connected properly.
- Re-verify control wiring from any external control devices.
- Set up auxiliary equipment with customer supplied parameters.
- Exercise the controller in Test Mode (combination controllers).
- Confirm cabling of controller to Motor and Line Feed.
- Apply Medium Voltage to the controller and perform operational checks.
- Run the controller motor system throughout the operational range to verify proper performance.
- User's personnel shall be required on-site to participate in the start-up of the system.

Start-up service is to be quoted at a per diem rate with an estimate of time required for commissioning.

On-site Training (Optional)

The Seller shall provide a qualified instructor to provide personnel with training that is specific to the MV controller system installed at the user's facility. The training session will be one (1) day in duration and will be customized for the user's needs. Manuals and documentation are provided for each participant, to a maximum of eight participants per class.

The training will cover the following topics:

- Basic motor theory
- Controller hardware
- Contactor hardware
- Hardware replacement procedures
- Power device replacement procedures (as applicable)
- Fault analysis and troubleshooting
- Preventative maintenance procedures

Time will be spent on lecture and hands-on training if user's equipment is available. Demos are not provided.

11.0 Basic Data Sheets

Table 11.A – Specifications

Description		Specifications
Controller		
Maximum Rated Voltage		5.0 or 7.2 kV
Nominal Voltage Ratings		2400V, 3300V, 4160V, 4800V, 6600V, 6900V
Removable Lifting Provisions Provided		Yes
Mounting Sill Channels	Quantity	Two (2)
	Removable	No
Weight of One Motor Controller		kg (lb) ❶
Maximum Power Cell Door Swing		cm (in.) ❶
Dielectric Voltage Withstand Rating (Insulation Test) for 60 seconds	2400 to 5000 V	13.25 kV
	7200 V	18.2 kV
Basic Impulse Level (B.I.L.) Rating		60 kV ❷
Enclosed Controller Current Rating		❸
Fault Withstand Current Rating		50 kA RMS SYM (80 kA RMS ASYM)
Fault Withstand MVA Ratings as Fused NEMA Class E2 Controller	5000 V	350 MVA SYM
	7200 V	500 MVA SYM
Minimum Insulation Creepage-to-Ground and Between Phases		89 mm (3.5 in.)

❶ Refer to Table 11.N – Structure, Dimensions and Weights on page 50.

❷ The BIL rating must be derated for altitudes above 1000 m (3300 ft.) Refer to Table 11.M – Controller Deratings on page 48.

❸ Refer to Table 11.L – Controller Ratings and Table 11.M – Controller Deratings on page 48.

11.0 Basic Data Sheets (cont.)

Table 11.A – Specifications (cont.)

Description	Specifications	
Main Horizontal Power Bus		
Standard Bus Bar Material	Tin-plated copper	
Optional Bus Bar Material	Silver-plated copper	
Continuous Current Rating at 40°C (104°F)	1200, 2000 and 3000 A	
Maximum Full Load Temperature Rise	65°C (149°F)	
Maximum Full Load Temperature	105°C (221°F)	
Short Circuit Withstand Current Rating (3 sec.)	60 kA RMS SYM (96 kA ASYM)	
Type of Bus Bracing	Molded glass polyester Anti-hygroscopic	
Dimensions per Phase	1200 A	Qty 1 – 6 x 100 mm (1/4 x 4 in.)
	2000 A	Qty 2 – 6 x 100 mm (1/4 x 4 in.)
	3000 A	Qty 2 – 9.5 x 127 mm (3/8 x 5 in.)
Cross Sectional Area per Phase	1200 A	65 mm^2 (1.0 $in.^2$) total
	2000 A	129 mm^2 (2.0 $in.^2$) total
	3000 A	242 mm^2 (3.75 $in.^2$) total
Insulating Material Between Phases and Ground	Air (Standard)	
Optional Insulation Material for Main Horizontal Bus	Type:	Sleeve, heat shrink
	Material:	Polyolefin
	Thickness:	1.4 mm (0.055 in. / 55 mils)
	Anti-hygroscopic:	0.5 to 1%
	Dielectric Strength:	900 V/mil (49.5 kV total)
Vertical Power Bus		
Bus Bar Material	Tin-plated copper	
Continuous Current Rating at 40°C (104°F)	400, 600 and 800 A	
Short Circuit Withstand Current Rating (½ cycle)	50 kA RMS SYM (80 kA ASYM)	
Insulation Material for Vertical Bus	Type:	Sleeve, heat shrink
	Material:	Polyolefin
	Thickness:	1.14 mm (0.045 in. / 45 mils)
	Anti-hygroscopic:	0.5 to 1%
	Dielectric Strength:	900 V/mil (40.5 kV total)
Ground Bus		
Ground Bus Material	Bare copper	
Optional Ground Bus Material	Tin-plated copper	
Continuous Current Rating at 40°C (104°F)	600 A	
Dimensions per Phase	600 A	6 x 51 mm (1/4 x 2 in.)
Cross Sectional Area	600 A	32 mm^2 (0.5 $in.^2$) total

Table 11.A – Specifications (cont.)

Description	Specifications		
Power Fuses and Fuse Holders			
This section details the power fuse and fuse holder technical information to which each medium voltage product conforms. It includes information on E-rated and R-rated fuses, as well as mounting dimensions.			
Fuse Types (Typical)			
R Rated: 2R to 12R	A480R – 5.0 kV		
19R to 38R, 48X, 57X	A051B – 5.0 kV		
2R to 38R, 48X, 57X	A072 – 7.2 kV		
Interrupting Ratings: 5.5 kV, 8.25 kV	50 kA RMS SYM (80 kA RMS ASYM)		
E Rated: 10E to 900E	A055 – 5.5 kV		
10E to 200E	A825X/A083B – 8.25 kV		
Interrupting Ratings: 5.5 kV, 8.25 kV	50 kA RMS SYM (80 kA RMS ASYM)		
Mounting (Center) Dimensions			
Clip-On	304.8 mm (12.0 in.)		
Bolt-On	454.2 mm (17.88 in.) *or* 511.6 mm (20.14 in.)		
Power Losses			
Power Cell Losses (approximate)	Current (A)	Fuse Size	Losses (kW) ± 10%
	90	6R	.125
	180	12R	.35
	240	18R	.51
	360	24R	1.0
	600	48X	1.5
	800	57X	2.0
Power Bus Losses (approximate)	Bus Rating (A)		Fully Loaded Bus Losses per 915 mm (36 in.) Section (Watts) ±%
	1200		150
	2000		200
	3000		200
Control Power Transformer Losses	The losses from a 500 VA control power transformer fully loaded is approximately 50 W per controller.		
Low Voltage Panel Losses	The losses from the standard control circuit is approximately 25 W per controller.		

11.0 Basic Data Sheets (cont.)

Table 11.B – Bulletin 1502 Medium Voltage 400 Amp Contactor Ratings

Description			Specification
Voltage Ratings ❶			
Maximum Rated Voltage			7200
System Voltages			2400 3300 4160 4800 6600 6900
Dielectric Voltage Withstand Rating	For 60 seconds (kV)		18.2 / 20 (IEC)
Basic Impulse Level (B.I.L.) Withstand	Phase-to-Ground, Phase-to-Phase (kV)		60
Frequency Ratings	Hertz		50 / 60
Current Ratings ❶			
Rated Continuous Current (Amps)			400
Maximum Interrupting Current Rating (RMS Sym Amps)	2400 V		6300
	5000 V		6300
	7200 V ❷		6000
Maximum Interrupting MVA Rating (Sym MVA)	2400 V		25
	5000 V		50
	7200 V ❷		75
Short-Circuit Withstand at Rated Voltage	Current Peak ½ cycle (kA)		60
Short Time Current Rating Capability	For 1 second (kA)		6.0
	For 30 seconds (kA)		2.4
Chop Current (Average RMS Amps)			0.5
Make and Break Capability at Rated Voltage (kA)			4.0
Ambient Temperature	°C		40
Contactor Coil Data (Series E)			
Control Voltage (V_{CTL})	Coil Voltage (V_{CL})		
Electro-Mechanical (Relay) Control (Mechanical Latch Only)			
120 VAC	110 VDC	Close Current (A_{DC})	5.6
		Trip Current (A_{DC})	6.0
		Pick-up Voltage	102
		Trip Voltage	84
IntelliVAC Control (Electrically Held & Mechanical Latch)			
110 to 240 VAC or 110 to 250 VDC ❸	VAC: $V_{CL} = \sqrt{2} \times V_{CTL}$ (Max.)	Close Current (A_{DC}, 200 milliseconds)	4.3
		Hold Current (A_{DC})	0.48
		Pick-up Voltage ❸	95
		Drop-out Voltage ❸	75
	VDC: $V_{CL} = V_{CTL}$	Trip Current (A_{DC}, 200 milliseconds)	5.5
		Trip Voltage ❸	70

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to Table 11.M - Controller Derating Chart on page 48 for ratings above this altitude.

❷ The IEC rating at 7200 V (RMS Sym.) is 5300 Amps / 66 MVA.

❸ Control voltage, as measured at the input of the IntelliVAC control module.

❹ Provided that regular maintenance is performed.

❺ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051_-EN-P).

❻ The full Altitude range is available with the IntelliVAC control module only, and the IntelliVAC is to be configured accordingly (refer to publication 1503-UM051_-EN-P). The standard mechanical latch contactors, if used with electro-mechanical control, are designed for -1000 to 1000 meters (-3300 to 3300 feet). Higher altitudes are possible by changing the contactor return springs.

❼ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

Table 11.B – Bulletin 1502 Medium Voltage 400 Amp Contactor Ratings (cont.)

Description			Specifications
Contactor Coil Data (Series D)			
Control and Coil Voltage	120 VAC / 110 VDC	Coil Inrush Current (A) – Electrically Held	7.3
		Coil Inrush Current (A) – Mechanical Latch	11.5
		Coil Inrush Current (A) – Mechanical Latch Trip	5.1
		Coil Continuous Current (A)	0.13
		Coil Pick-up Voltage (VAC)	102
		Coil Drop-out Voltage (VAC)	75
	230 VAC / 210 VDC	Coil Inrush Current (A) – Electrically Held	8.3
		Coil Inrush Current (A) – Mechanical Latch	NA
		Coil Inrush Current (A) – Mechanical Latch Trip	NA
		Coil Continuous Current (A)	0.11
		Coil Pick-up Voltage (VAC)	190
		Coil Drop-out Voltage (VAC)	140
Operational Characteristics			
Mechanical Life (Operations) x 1000 ❹		Electrically Held	2500
		Mechanical Latch	100
Electrical Life (Operations) x 1000 ❹			1000
Switching Frequency (Operations per hour)		Electrically Held	600
		Mechanical Latch	150
Opening and Closing Times (Series E)			
Electro-Mechanical (Relay) Control (Mechanical Latch Only)			
Maximum Closing Time (120 VAC)		50 or 60 Hz (milliseconds)	160
Maximum Opening Time (120 VAC)		50 or 60 Hz (milliseconds)	50
IntelliVAC Control (Electrically Held & Mechanical Latch)			
Maximum Closing Time		120 / 240 VAC (milliseconds)	100 / 70
Maximum Opening Time (without delay) ❺		120 to 240 VAC (milliseconds)	60
Opening and Closing Times (Series D)			
Maximum Closing Time		50 or 60 Hz (milliseconds)	160
Maximum Opening Time (Normal Drop Out)		50 or 60 Hz (milliseconds)	130
Maximum Opening Time (Fast Drop Out and Mechanical Latch)		50 or 60 Hz (milliseconds)	50
Capacitor Switching (max. KVAR)			
System Voltage		2400 V	800
		4160 V	1400
		6900 V	2000
General			
Standard Altitude Capability (meters / feet) ❶ ❻			-1000 to 5000 / -3300 to 16500
Contactor Weight (kg / lbs)			21.8 / 48
Auxiliary Contact Rating			A600
Auxiliary Contacts on the Vacuum Contactor (Max.) ❼			3 N.O. / 3 N.C.

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to Table 11.M - Controller Derating Chart on page 48 for ratings above this altitude.

❷ The IEC rating at 7200 V (RMS Sym.) is 5300 Amps / 66 MVA.

❸ Control voltage, as measured at the input of the IntelliVAC control module.

❹ Provided that regular maintenance is performed.

❺ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051_-EN-P).

❻ The full Altitude range is available with the IntelliVAC control module only, and the IntelliVAC is to be configured accordingly (refer to publication 1503-UM051_-EN-P). If used with electro-mechanical control, contactors are designed for -1000 to 1000 meters (-3300 to 3300 feet). Higher altitudes are possible by changing the contactor return springs.

❼ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

11.0 Basic Data Sheets (cont.)

Table 11.C – Bulletin 1502 Medium Voltage 800 Amp Contactor Ratings

Description			Specification
Voltage Ratings ❶			
Maximum Rated Voltage			7200
System Voltages			2400 3300 4160 4800 6600 6900
Dielectric Voltage Withstand Rating		For 60 seconds (kV)	18.2 / 20 (IEC)
Basic Impulse Level (B.I.L.) Withstand		Phase to Ground, Phase to Phase (kV)	60
Frequency Ratings		Hertz	50 / 60
Current Ratings ❶			
Rated Continuous Current (Amps)			800
Maximum Interrupting Current Rating (RMS Sym Amps)		2400 V	12,500
		5000 V	12,500
		7200 V	12,500
Maximum Interrupting MVA Rating (Sym MVA)		2400 V	50
		5000 V	100
		7200 V	150
Short-Circuit Withstand at Rated Voltage		Current Peak ½ cycle (kA)	85
Short Time Current Rating Capability		For 1 second (kA)	12.0
		For 30 seconds (kA)	4.8
Chop Current (Average RMS Amps)			0.5
Make and Break Capability at Rated Voltage (kA)			8.0
Ambient Temperature		°C	40
Contactor Coil Data (Series E)			
Control Voltage (V_{CTL})	Coil Voltage (V_{CL})		
110 to 240 VAC or 110 to 250 VDC ❷	VAC: $V_{CL} = \sqrt{2} \times V_{CTL}$ (Max.) VDC: $V_{CL} = V_{CTL}$	Close Current (A_{DC}, 200 milliseconds)	12
		Hold Current (A_{DC})	0.7
		Pick-up Voltage ❷	95
		Drop-out Voltage ❷	75
		Trip Current (A_{DC}, 200 milliseconds)	5.2
		Trip Voltage ❷	70
Contactor Coil Data (Series D)			
Control Voltage (V_{CTL})	Coil Voltage (V_{CL})		
120 VAC	110 VDC	Coil Inrush Current (A) – Electrically Held	13.1
		Coil Inrush Current (A) – Mechanical Latch	13.1
		Coil Inrush Current (A) – Mechanical Latch Trip	5.6
		Coil Continuous Current (A)	0.24
		Coil Pick-up Voltage (VAC)	102
		Coil Drop-out Voltage (VAC)	75

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to Table 11.M - Controller Derating Chart on page 48 for ratings above this altitude.
❷ Control voltage, as measured at the input of the IntelliVAC control module.
❸ Provided that regular maintenance is performed.
❹ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051_-EN-P).
❺ FDO = Fast Drop-Out. NDO = Normal Drop-Out.
❻ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

Table 11.C – Bulletin 1502 Medium Voltage 800 Amp Contactor Ratings (cont.)

Description		Specifications
Operational Characteristics		
Mechanical Life (Operations) x 1000 ❸	Electrically Held	250
	Mechanical Latch	100
Electrical Life (Operations) x 1000 ❸		250
Switching Frequency (Operations per hour)	Electrically Held	600
	Mechanical Latch	150
Opening and Closing Times (Series E)		
Maximum Closing Time	120 / 240 VAC (milliseconds)	150
Maximum Opening Time (without delay) ❹	120 to 240 VAC (milliseconds)	60
Opening and Closing Times (Series D)		
Maximum Closing Time	50 or 60 Hz (milliseconds)	200
Maximum Opening Time (Normal Drop Out)	50 or 60 Hz (milliseconds)	240
Maximum Opening Time (Fast Drop Out and Mechanical Latch)	50 or 60 Hz (milliseconds)	60
Capacitor Switching (max. KVAR)		
System Voltage	2400 V	2000
	4160 V	3000
	6900 V	4000
General		
Standard Altitude Capability (meters / feet) ❶ ❼		-1,000 to 5,000 / -3,300 to 16,500
Contactor Weight (kg / lbs)		45 / 100
Auxiliary Contact Rating		A600
Auxiliary Contacts on the Vacuum Contactor (Max.) ❻		3 N.O. / 3 N.C.

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to Table 11.M - Controller Derating Chart on page 48 for ratings above this altitude.
❷ Control voltage, as measured at the input of the IntelliVAC control module.
❸ Provided that regular maintenance is performed.
❹ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051_-EN-P).
❺ FDO = Fast Drop-Out. NDO = Normal Drop-Out.
❻ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.
❼ Altitude adjustment required.

11.0 Basic Data Sheets (cont.)

Table 11.D – Control Wire and Control Relays

Description		Specifications
Control Wire		
All Medium Voltage structures shall be equipped with control wire which meets the following specifications:		
Type		TEW, Stranded Copper Wire (Tinned)
AWG Size (Control Circuit)		#14 AWG
AWG Size (Current Transformer Circuit)		#12 AWG
Number of Strands		19
Maximum Voltage Rating		600 V
Maximum Rated Temperature		105°C (221°F)
Electro/Mechanical Relays		
Control Relays used in the medium voltage produce line shall conform to the following design standards:		
Pick-up Time	CR1	20 msec
	CR2	30 msec
Drop-Out Time	CR1	20 msec
	CR2	75 msec
Pick-Up Current	CR1	0.60 AC amps
	CR2	0.10 DC amps
Sealed Current	CR1	0.07 AC amps
	CR2	0.10 DC amps

Table 11.E – Power Wire

Description	Specifications
Power wire used to feed the primary of the control power transformer or potential transformers is as follows:	
AWG Size	PT – #8 AWG / CPT – #12 AWG
Insulation Rating	8.0 kV
Maximum Temperature Rating	150°C (302°F)

The controller shall be wired with the following non-shielded, stranded wire type, based on the current ratings:

Controller Rating (Amps)	AWG Size	Type	Insulation Rating	Maximum Temperature Rating
200	#2	EP-CSPE MV90	8.0 kV	90°C (194°F)
400	#4/0	EP-CSPE MV90	8.0 kV	90°C (194°F)
450	350 MCM	EP-CSPE MV90	8.0 kV	90°C (194°F)
600	(2) x #4/0	EP-CSPE MV90	8.0 kV	90°C (194°F)
800	(2) x 350 kcmil	EP-CSPE MV90	8.0 kV	90°C (194°F)

Table 11.F – IntelliVAC Control Module Specifications ❶

IntelliVAC Catalog Numbers		Vacuum Contactor Type
1503VC-BMC5	IntelliVAC	Electrically Held or Mechanical Latch
1503VC-BMC5-EM1	IntelliVAC Plus	
1503VC-BMC5-MC1	IntelliVAC MC	Electrically Held
Ratings and Approvals		
Input Voltage		AC – 110 to 240 V, 47 to 63 Hz ❶
		DC – 110 to 250 V
Input Current ❷	AC ❶	Inrush (max.) – 25 A peak (½ cycle)
		Idle (max.) – 125 mA
		Close (max.) – 11.3 A
		Hold (max.) – 300 mA
		Latch Trip (max.) – 7.0 A
	DC ❶	Inrush (max.) – 25 A
		Idle (max.) – 355 mA
		Close (max.) – 4.8 A
		Hold (max.) – 100 mA
		Latch Trip (max.) – 3.7 A
Command Inputs		AC – 100 to 240 V, 9 mA max. ❶
		DC – 50 to 250 V, 9 mA max.
IntelliVAC Plus Inputs ❹		AC – 100 to 240 V, 9 mA max. ❶
		DC – 50 to 250 V, 9 mA max.
Status Output Contacts		AC – 250 V, 5.A, R load ❶
		DC – 30 V, 5 A, R load
IntelliVAC Plus Output Contacts ❹		AC – 250 V, 5 A, R load ❶
		DC – 30 V, 5 A, R load
Standards and Approval		cULus, IEC, CE

❶ All AC values are rms, except where noted.
❷ The maximum currents shown are for either the 400 or 800 A Bulletin 1502 vacuum contactors. Close current duration is 200 milliseconds.
❸ Common ratings for all versions of IntelliVAC, except where noted.
❹ Available with IntelliVAC Plus (1503VC-EMC1) only.
❺ This kit includes a "Plus" control board, half of the enclosure to house both control boards as well as product labels and documentation to aid in the field upgrade.
❻ This kit includes an "MC" control board, half of the enclosure to house both control boards as well as product labels and documentation to aid in the field upgrade.
❼ A wire harness is required for Bulletin 1502 vacuum contactors when IntelliVAC is used.

11.0 Basic Data Sheets (cont.)

Table 11.G – Control Power Transformer

Description	Specifications
Type	Dry
Voltage Class	5.0 and 7.2 kV
Frequency	50/60 Hz
Standard Capacity VA Rating	500 VA
Optional VA Ratings	1000 VA 2000 VA 3000 VA
Primary Voltage, Single Phase ❶	2400 V AC 4800 V AC 3300 V AC 6600 V AC 4160 V AC 7200 V AC
Rated Secondary Voltage	110/120 *or* 220/240 V AC
Basic Impulse Level (B.I.L.) Rating	25 kV
Primary Fuses	
Type (Current Limiting)	A480T – 4.8 kV A720T – 7.2 kV
Maximum Continuous Current	Sized According to Requirements
Interrupting Rating	50 kA RMS SYM (80 kA RMS ASYM)
Secondary Fuses	
Type	ATM
Maximum Continuous Current	Sized According to Requirements

❶ Primary voltages above 5000 V are supplied according to the application.

Table 11.H – Potential Transformer

Description	Specifications	
Voltage Class	5.0 kV	7.2 kV
Frequency	50/60 Hz	
Standard Capacity VA Rating	425 VA	300 VA
Optional VA Ratings	None	
Primary Voltage Single Phase	2400 V AC 3300 V AC 4160 V AC 4800 V AC	7200 V AC
Rated Secondary Voltage	120 V AC (60 Hz), 110 V AC (50 Hz)	
Basic Impulse Level (B.I.L.) Rating	45 kV	60 kV
Metering Accuracy	0.3 WX, 0.6 MY, 1.2 Z	0.3 WXMY, 1.2 Z

Table 11.I – Potential Transformer Ratings

PT Burden Designation	VA	Burden PF
W	12.5	0.1
X	25	0.7
M	35	0.2
Y	75	0.85
YY	150	0.85
Z	200	0.85

Table 11.J – Current Transformer

Description		Specifications	
Type	Bar	Wound Primary	
	Donut	Toroid	
Voltage Class	Bar	7.2 kV	
	Donut	600 V	
Basic Impulse Level (B.I.L.) Rating	Bar	60 kV	
	Donut	10 kV ❶	
Momentary (Short-Circuit) Current Rating		Withstands the Let-Through of the fuse	
Secondary Current Rating		5.0 A ❹	
Maximum Continuous Secondary Current		7.5 A (Bar and Donut) at 30°C (86°F) ambient (Most ratios)	
Accuracy	Type	Metering	Relaying
	Bar	0.3 – BO.1 0.6 – BO.5 0.6 – BO.9 1.2 – B1.8	10T20
	Donut	❷	10C20 (most ratios)
Bar Current Transformer			
Rated Short-Circuit Time Thermal Current		18 kA RMS for 1 sec ❸	
Rated Short Time Mechanical Current		40 kA RMS for 1 sec ❸	

❶ B.I.L. rating of 60 kV when used with 8.0 kV power cable.

❷ Accuracy depends on the C.T. ratio, but most meet bar-type specification.

❸ The maximum rating depends on the C.T. ratio.

❹ Some donut CTs used for ground fault protection may have secondaries of different current ratings.

11.0 Basic Data Sheets (cont.)

Table 11.K – Environmental Ratings

Environmental Ratings	UL/CSA/NEMA	IEC
Operating Temperature Range	0°C to 40°C (32°F to 104°F)	
Storage and Transportation Temperature Range	-20°C to +75°C (-4°F to 149°F)	
Altitude	1,000 meters (3,300 feet)	
Humidity	5% to 95% (non condensing)	
Pollution Degree	2	
Seismic (UBC Rating) ❶	1, 2, 3, 4	

❶ Some units may require special bracing. Contact factory for more information.

Table 11.L – Controller Ratings

Starter Size and Type	NEMA Type 1 Enclosure				NEMA Type 1A, 12, 3R Enclosure, Arc Resistant			
	Max. Continuous Current (amps) ❸	Horsepower ❷			Max. Continuous Current (amps) ❸	Horsepower ❷		
		2400 V	4160 V	6900 V		2400 V	4160 V	6900 V
1-unit, 400 A	360	1500	2500	4000	360	1500	2500	4000
	400	1750	3000	4500	400	1750	3000	4500
2-unit structure with standard blank doors	260 Top Cell	1000	1750	3000	260 Top Cell	1000	1750	3000
	300 Bottom Cell	1250	2250	3500	300 Bottom Cell	1250	2250	3500
	560 Total/Structure	2250	4000	6500	560 Total/Structure	2250	4000	6500
2-unit structure with vented door Option ❶	300 Top Cell	1250	2250	3500	N/A	—	—	—
	360 Bottom Cell	1500	2500	4500	N/A	—	—	—
	660 Total/Structure	2750	4750	8000	N/A	—	—	—
600 A	600	2500	4500	7000	540	2250	4000	7000
800 A	720	3000	5500	9000	720	3000	5500	9000
800 A with vented door Option ❶	800	3500	6000	9000	N/A	—	—	—

❶ The power cell doors are vented. Specify unit modification "-100T" to configure. Not available with arc resistant option.

❷ The horsepower values are based on assumed Full Load Current and a Service Factor of 1.0 motor data. The actual Full Load Current and Service Factor ratings determine the limits.

❸ The standard current and basic impulse level (B.I.L.) ratings are valid up to an altitude of 1000 m (3300 ft). For applications above 1000 m (3300 ft), the maximum continuous current and B.I.L. withstand ratings shall be reduced per Table 11.M.

Table 11.M – Controller Deratings

Altitude Range	Power Cell Rating				Reduce B.I.L. Withstand Rating By:
	180 A	360 A	600 A	800 A	
	❶ Reduce Max. Continuous Current Rating By:				
1000 to 2000 m (3,300 to 6,600 ft.)	10 A	10 A	15 A	20 A	6.0 kV
2001 to 3000 m (6,601 to 9900 ft.)	20 A	20 A	30 A	40 A	12.0 kV
3001 to 4000 m (9,901 to 13,200 ft.)	30 A	30 A	45 A	60 A	18.0 kV
4001 to 5000 m (13,201 to 16,500 ft.)	40 A	40 A	60 A	80 A	24.0 kV

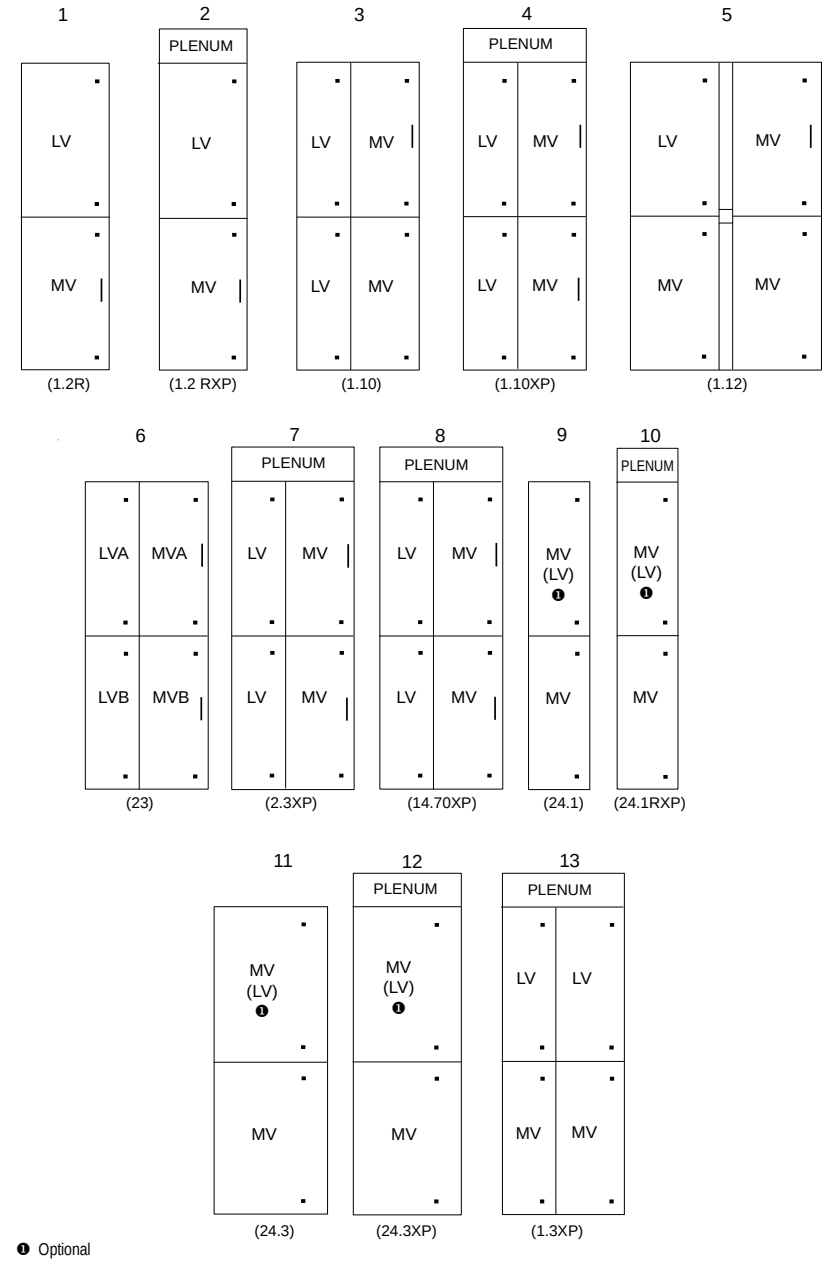
❶ Current deratings shown are the minimum levels. Additional derating may be required due to power fuse limitations. Please consult factory for additional details.

Structure Styles, Dimensions and Weights

The structures shown below are the standard configurations. For other structure types and complete dimension details, consult the factory for assistance.

Structure Styles

LV – Low Voltage Compartment
MV – Medium Voltage Compartment/Power Cell



❶ Optional

11.0 Basic Data Sheets (cont.)

Table 11.N – Structure, Dimensions and Weights ❷

Item No.	Bulletin No.	Description	Dimensions (W x H x D)	Weight	Power Cell Door Swing
1	1512A	1-High, 400 A FVNR Controller	661 mm x 2315 mm x 915 mm (26 in. x 91 in. x 36 in.)	490 kg (1078 lbs)	597 mm (23.5 in.)
2	1512A	1-High, 400 A FVNR Controller (Arc Resistant) ❶	661 mm x 3264 mm x 915 mm ❸ (26 in. x 128.5 in. x 36 in.)	600 kg (1320 lbs)	597 mm (23.5 in.)
3	1512A	1-High, 600 A FVNR Controller	915 mm x 2315 mm x 915 mm (36 in. x 91 in. x 36 in.)	614 kg (1350 lbs)	508 mm (20.0 in.)
4	1512A	1-High, 600A FVNR Controller (Arc Resistant) ❶	915 mm x 3264 mm x 915 mm ❸ (36 in. x 128.5 in. x 36 in.)	773 kg (1700 lbs)	857 mm (33.75 in.)
5	1512A	1-High, 800 A FVNR Controller	1422 mm x 2315 mm x 915 mm (56 in. x 91 in. x 36 in.)	816 kg (1800 lbs)	597 mm (23.5 in.)
6	1512B	2-High, 400 A FVNR Controller	915 mm x 2315 mm x 915 mm (36 in. x 91 in. x 36 in.)	802 kg (1770 lbs)	508 mm (20.0 in.)
7	1512B	2-High, 400 A FVNR Controller (Arc Resistant) ❶	915 mm x 3264 mm x 915 mm ❸ (36 in. x 128.5 in. x 36 in.)	1050 kg (2310 lbs)	857 mm (33.75 in.)
8	1562E	200 to 400A RVSS Controller (Arc Resistant) ❶❹	915 mm x 3264 mm x 915 mm ❸ (36 in. x 128.5 in. x 36 in.)	886 kg (1950 lbs)	857 mm (33.75 in.)
9	1591A	Incoming Line Unit	457 mm x 2315 mm x 915 mm (18 in. x 91 in. x 36 in.)	272 kg (600 lbs)	394 mm (15.5 in.)
10	1591A	Incoming Line Unit (Arc Resistant) ❶	457 mm x 3264 mm x 915 mm ❸ (18 in. x 128.5 in. X 36 in.)	464 kg (1020 lbs)	394 mm (15.5 in.)
11	1591A	Incoming Line Unit	915 mm x 2315 mm x 915 mm (36 in. x 91 in. x 36 in.)	363 kg (800 lbs)	857 mm (33.75 in.)
12	1591A	Incoming Line Unit (Arc Resistant) ❶	915 mm x 3264 mm x 915 mm ❸ (36 in. x 128.5 in. x 36 in.)	663 kg (1459 lbs)	857 mm (33.75 in.)
13	1512A	1-High, 800 A Controller (Arc Resistant) ❶	1575 mm x 3264 mm x 915 mm (62 in. x 128.5 in. x 36 in.)	1400 kg (3080 lbs)	857 mm (33.75 in.)

❶ Height dimension includes plenum (953 mm [37.5 in.]) which is removed for shipping, and installed by customer.
❷ For other controller types, contact factory for complete structure and dimension details.
❸ Depth dimension includes plenum which extends 254 mm (10 in.) in front of structure.
❹ Available up to 5 kV. Refer to Publication 1560E-SR022_-EN-P for additional details.

12.0 References

Publication Number	Title
1500-2.13	Vacuum Contactor Switches, Surge Phenomenon and its Effects
1500-2.21	Application of Surge Protection to Vacuum Contactors
1500-2.7	Medium Voltage Bus Support
1500-2.8	Copper Power Bus • Tin vs. Silver Plate
1500-SG001_-EN-P	Selection Guide • Medium Voltage Controllers
1500-TD220_-EN-P	Test Procedures for Medium Voltage Products
1500-UM055_-EN-P	User Manual • CENTERLINE Medium Voltage Controller, 400A, Series B, Two-High Cabinet
1502-UM050_-EN-P	User Manual • Medium Voltage Contactor, 400 A (Series D)
1502-UM051_-EN-P	User Manual • Medium Voltage Contactor, 800 A
1502-UM052_-EN-P	User Manual • Medium Voltage Contactor, 400 A (Series E)
1901-UM020_-EN-P	Installation Manual • 1901 SyncPro
1912B-UM050_-EN-P	User Manual • Brush-Type Synchronous Motor Controller, 36” 400A
QES-BR001_-EN-D	Rockwell Automation Control Systems
6500-CO001_-EN-P	Terms and Conditions
INTERNET	www.ab.com/mvb

CENTERLINE® Medium Voltage
Motor Control Center Specification Checklist

for Bulletin 1500 and Bulletin 1900

Check boxes and fill in blanks as required.

Customer: **User:**

Prepared by: **Office:**

Project Reference:

Standards

☐ UL Labeled ☐ NEMA ☐ ICS Specification No. _____

☐ CSA Certified ☐ Service Entrance ☐ Other: _____

Incoming Power

Line Voltage: ☐ 2400 ☐ 3300 ☐ 4160 ☐ 4800 ☐ 6000

☐ 6600 ☐ 7200 ☐ Other _____

Power: ☐ 3-phase 3-wire ☐ 3-phase 4 wire

Frequency: ☐ 50 Hz ☐ 60 Hz

Available Fault Current: _____ kA

Environmental

Elevation: _____ meters ☐ Above sea level ☐ Below sea level

Motor

Motor Full Load Amps: _____

Motor Service Factor: ☐ 1.0 ☐ 1.15 ☐ Other (specify) _____

RTDs: ☐ None ☐ 100 ohm Platinum ☐ 10 ohm Copper

☐ 100 ohm Nickel ☐ 120 ohm Nickel

Structure

NEMA Type: ☐ Type 1 ☐ Type 1 w/gasket

☐ Type 12 ☐ Type 3R non-walk-in

Paint Color: ☐ ANSI 49 medium light gray ☐ ANSI 61 light gray

☐ Special paint - describe: _____

Options: ☐ 2” x 4” wireway ☐ 6” x 6” wireway ☐ Export crating

☐ Arc Resistant (Type 2 Accessibility per IEEE C37.20.7)

☐ Other: _____

Bus

Horizontal power bus: ☐ 1200 A copper ☐ 2000 A copper ☐ 3000 A copper
(60 kA RMS symmetrical) ☐ Tin plated ☐ Silver plated ☐ Insulated

Horizontal ground bus: ☐ 1/4” x 2” unplated copper ☐ 1/4” x 2” tin plated copper

Incoming Line Termination

To main power bus: Located in Section No. _____ ☐ Top ☐ Bottom
No. of cables per phase _____ Cable Size _____
☐ Lugs by others ☐ Crimp compression lugs

Incoming line unit: Located in Section No. _____ ☐ Top ☐ Bottom
No. of cables per phase _____ Cable Size _____
☐ Lugs by others ☐ Crimp compression lugs

Main load break switch: Ampere size _____
☐ Fused ☐ Non-Fused
Located in Section No. _____ ☐ Top ☐ Bottom
No. of cables per phase _____ Cable Size _____
☐ Lugs by others ☐ Crimp compression lugs

Incoming metering options: No. of current transformers required _____
No. of potential transformers required _____
☐ Ammeter ☐ Ammeter Switch ☐ Watt-hour meter ☐ Power Monitor
☐ Voltmeter ☐ Voltmeter Switch ☐ Digital meter – Describe: _____
☐ Other: _____

Transition: ☐ Existing structure: Describe or series number – _____

Load Termination

Outgoing Load Cable Connection: ☐ Top ☐ Bottom
Load Cables per phase: ☐ 1 ☐ 2
Load Cable Size (specify): _____

Combination Starter Units

Starter Types:
☐ FVNR (1-high) ☐ FVNR (2-high) ☐ FVTF (1-high) ☐ FVTF (2-high)
☐ FVR ☐ RVAT ☐ RVR ☐ BTSYN
☐ BLSYN ☐ Prepared space – for FVNR only
☐ Other: _____

Motor Protection Relays:
☐ Allen-Bradley Bulletin 825P
☐ Allen-Bradley Bulletin 592 (Eutectic Alloy Type)
☐ Other (specify): _____

Unit Nameplates:
☐ 3 line ☐ 6 line
☐ Black letters on white ☐ White letters on black

Control Power:
☐ Separate Control 120 volts
☐ Control Power Transformer ☐ 120V Sec. ☐ 120/240V Sec.
☐ Standard 500 VA ☐ 1000 VA ☐ 2000 VA ☐ 3000 VA

Starter Options:
☐ Pilot devices ☐ Push buttons _____
☐ Selector switches
☐ Pilot lights – Qty _____ Color(s) _____
☐ Transformer type ☐ Push-to-test ☐ Other _____
☐ Auxiliary relays, timers – describe: _____
☐ Other – describe: _____

Other Units

☐ Feeder Load Break Switches Description: _____

☐ Solid State Starters Description: _____

☐ Drives: Description: _____

Comments / Additional Notes:

www.rockwellautomation.com

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Medium Voltage Products, 135 Dundas Street, Cambridge, ON, N1R 5X1 Canada, Tel: (1) 519.740.4100, Fax: (1) 519.623.8930, www.ab.com/mvb

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Supersedes Publication 1500-SR020G-EN-P – June 2008
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General Overview of Rockwell Automation Standard testing on the Powerflex drive.

The following list provides an overview of the testing which is completed on each drive, by our quality control personnel, before shipment of the product.
This is not what is done during a witness test as it has already been competed during our regular testing procedures.

1. Read all the notes on the DD and ED and review the DD and ED to develop an understanding of the job requirements.

2. Check all power connections for tightness by putting a wrench on or pulling on each connection. Check all connections for cross-threaded hardware.

3. Check for the required clearances between components between phase to phase, and phase to ground.

4. Visually check to verify electrical clearances, creepage allowances and bend radii are within the design specifications.

5. Perform continuity checks on all parts of the control circuit, which cannot be verified by cycling.

6. Trace or perform continuity checks on all power wiring.

7. Perform a Dielectric Withstand Test, ensuring that any components that cannot handle such a test, such things like the Power supply boards, the voltage sensing boards, are not in the circuit for this test.

8. Using ohmmeter check L1, L2, L3 to R,S,T to confirm that all devices are commoned up. Hipot to the following values for 1 minute:

Less than 2500 volts	8.0 KVac	
2501 to 5000 volts	13.5 KVac	
5001 to 7200 volts	18.5 KVac	(about 21ma)

9. Verify that no SCRs and GTOs have been damaged as a result of the dielectric test by measuring from anode to cathode on all devices.

TEST POINT	EXPECTED RESISTANCE
Rectifier	
Rectifier Heatsink to Heatsink	42kΩ to 44kΩ
TP1 to Heatsink (Snubber Res)	60Ω
S1 to Heatsink (Sharing Res)	80kΩ
Gate TP1 to cathode TP2(Connected)	17Ω
Gate to cathode (Un-Con)	21Ω
Inverter	
Inv Heatsink to Heatsink (Reverse leads)	60kΩ or (50kΩ)
TP1 to Heatsink (Snubber Res)	10Ω
Gate TPG to cathode TPK	2kΩ to 1.7kΩ

10. Using an ohmmeter, check each element of the voltage sensing boards. The readings should be approximately 16 kohms. Look for consistent readings between the resistors.

11. Perform calibration tests on all power supplies, transducers and control boards.

MEDIUM VOLTAGE

TECHNICAL DATA

TYPICAL TEST PROCEDURES FOR MEDIUM VOLTAGE PRODUCTS

ALLEN-BRADLEY • ROCKWELL SOFTWARE

Rockwell Automation

Scope

This document provides a general description of the tests performed on medium voltage products manufactured at the Rockwell Automation facility in Cambridge, Ontario, Canada. All testing procedures are developed and controlled under the guidelines of the Rockwell Automation Quality System. This system is registered to ISO 9001 and is regularly reviewed and audited by a third party registrar.

The following tests are carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), European Standard (EN) and International Electrotechnical Commission (IEC), and to the capability of the Rockwell Automation Cambridge test facility.

Electrical

1. Functional checks are performed wherever possible; otherwise, inspection and continuity checks are made.
   - Continuity checks are performed on all parts of the control circuit that cannot be verified by cycling.
   - Trace or continuity checks are performed on all power wiring.
   - Control wiring is verified to ensure it is identical to that shown on the electrical diagrams, using both sides of the terminal blocks as indicated.
2. A “HI-POT” dielectric withstand test is performed on all buswork and power cables from phase to phase and phase to ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product’s nominal AC voltage. (See Table 1.A.)

Table 1.A – Hi-POT Tests on Medium Voltage Components

Medium Voltage Components	Nominal AC Voltage	Hi-POT AC Voltage	Duration
Starters	2300V to 5000V	16000 V	1 second
	5000V to 7200V	22000 V	1 second
Drives	2500 V	8000 V	1 minute
	5000 V	13500 V	1 minute
	7200 V	18500 V	1 minute
SMCs	2400 V	8000 V	1 minute
	3300V to 5000V	13250 V	1 minute
	5000V to 7200V	18500 V	1 minute

3. Component devices are functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.
   - Calibration of Printed Circuit Boards according to specifications.
   - I/O Checks
   - Programmable devices

4. Instruments, meters, protective devices and associated controls are functionally tested by applying the specified control signals, current and/or voltages. Multi-function protective relays and like devices are not fully programmed – these types of devices are only functionally tested.

5. The product must function in accordance with the electrical diagram.

   5.1 Medium Voltage Starters are inspected for the following:
   - Electrical interlocking
   - Motor protection and ground fault, if applicable

   5.2 Medium Voltage Smart Motor Controllers (SMCs) are inspected for the following:
   - Electrical interlocking
   - Motor protection and ground fault
   - Motor start tests at rated voltage
   - Motor stop tests (if applicable) at rated voltage

   5.2 Medium Voltage Drives are inspected for the following:
   - Control Power Failure Test
   - Rectifier Gating Checks
   - Inverter Gating Checks
   - Line Converter Tests
   - Machine Converter Tests
   - Load Tests

   a) Drives are accelerated to the test motor's nominal frequency, under load, decelerated to 10 Hz, then accelerated back to test motor's nominal frequency, with a ramp time of approximately ten seconds. This cycle can be repeated continuously for up to one hour.

   b) Drives are tested under constant load at the test motor's nominal frequency.

   5.3 MV OEM components are inspected per the following when applicable:
   - Electrical interlocks
   - Gating checks performed on SCRs (180 and 360A units)

6. Optional witness testing and combined drive/motor testing is available. Contact your Rockwell Automation representative for more details.

Physical Inspection

1. The product must meet all applicable engineering and workmanship standards and specifications.
   - All components are verified against engineering documentation to be present and correctly installed.
2. Warning nameplates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.
   - Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
   - Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
   - Verify operation of isolation switch handle and door interlocks. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.
3. All bus and bus connections are checked for proper clearance, creepage, phasing, and torque.

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Final Factory Tests and Inspections

Procedure	Inspection	Acceptance
	IN PROCESS INSPECTIONS	
DWI-15100-015-06	Low Voltage Panel Wiring	Workmanship Standards, Drawing Conformance
DWI-15100-015-06	Power Cage Module	Inspection
DWI-15100-015-06	Sub Assembly	In Process Check
DWI-15100-015-06	Up-ender assembly	In Process Check
DWI-15100-015-06	Final Assembly	In Process Check
DWI-15100-015-06	Rear Panel Assembly & Completion of Assembly Wiring	In Process Check CSP-2490-179-03
	PRINTED CIRCUIT BOARD TEST	
DWI-15100-015-06	Drive Control Board	PCB Board Functional Test
DWI-15100-015-06	Communication Interface Board	PCB Board Functional Test
DWI-15100-015-06	Signal Conditioning Board	PCB Board Functional Test
DWI-15100-015-06	XIO Board	PCB Board Functional Test
DWI-15100-015-06	Isolated gate Drive Power Supply Board	PCB Board Functional Test
DWI-15100-015-06	Operator Interface Board	PCB Board Functional Test
DWI-15100-015-06	Transient Suppression Board	PCB Board Functional Test
DWI-15100-015-06	Voltage Sensing Board	PCB Board Functional Test
DWI-15100-015-06	Drive Control Board	PCB Board Burn In
DWI-15100-015-06	Communication Interface Board	PCB Board Burn In
DWI-15100-015-06	Signal Conditioning Board	PCB Board Burn In
DWI-15100-015-06	XIO Board	PCB Board Burn In
DWI-15100-015-06	Isolated gate Drive Power Supply Board	PCB Board Burn In
DWI-15100-015-06	Operator Interface Board	PCB Board Burn In
DWI-15100-015-06	Transient Suppression Board	PCB Board Burn In
DWI-15100-015-06	Voltatge Sensing Board	PCB Board Burn In
	INSPECTIONS OF COMPLETE VFD	
CSP-2490-198-08	Quality Control Inspection Card	Summary report card for all 7000
DWI-15100-015-06	Bus Compartment – Connection Check	Visual (Check Torque-seal)
DWI-15100-015-06	Cable Termination Direction	Visual
DWI-15100-015-06	CT Polarity	Per Drawing
DWI-15100-015-06	LEM Polarity	Per Drawing
DWI-15100-015-06	Phase to Phase Bus Clearance	3” min
DWI-15100-015-06	Phase to Ground Bus Clearance	3” min
DWI-15100-015-06	Power Cables Braced	18 inch max
DWI-15100-015-06	Structure Grounded in 2 places	Confirm
DWI-15100-015-06	Power Rating of Cable, bus, fuses, CT’s	Per Drawing

	INSPECTIONS OF COMPLETE VFD -Continued-	
DWI-15100-015-06	Paint Quality	DWI-35500-029
DWI-15100-015-06	Components on ED, DD & BOM present	Per Drawings
DWI-15100-015-06	Clearances, Creep-age & Bend Radii	UL 347 Nema ICS3-199
DWI-15100-015-06	Pull Test, very no cross threaded hardware	Confirm
DWI-15100-015-06	SGCT matching	Supplier Records
DWI-15100-015-06	Control Circuit Wiring	Continuity
DWI-15100-015-06	Power Circuit Wiring	Continuity
DWI-15100-015-06	PT wires, lugs, tagging, wire wraps	Visual
DWI-15100-015-06	Warning Labels, Nameplates	Visual
DWI-15100-015-06	Barriers in place	Visual
DWI-15100-015-06	Voltage Feedback Wiring	Confirm HV wire
DWI-15100-015-06	Fibre Optic Cables	Bend Radius
DWI-15600-001-03	Liquid Test	Confirm liquid installation

Listing of Tests

Procedure	**Test Method**	**Acceptance**
CSP-0280-004-04	Low Voltage Hi-Pot	208-600 Volt circuits – 2500 Vac 1 second withstand 48-120 Volt circuits – 1500 Vac 1 minute withstand
DWI-15100-015-06	Dielectric Withstand VFD	13.5 k Vac 1 minute (2501-5000V)
DWI-15100-015-06	SGCT Anode to Cathode Resistance	Correct Ohmic Value
DWI-15100-015-06	Voltage Sensing Board Resistance	16 kOhms
DWI-15100-015-06	Control Power Calibration	Correct voltage on 27 test points
DWI-15100-015-06	Voltage at logic board connectors, HECs and 56 V Output of IGDPS	Correct voltage & polarity
DWI-15100-015-06	Signal Conditioners	Correct voltage, polarity & dip switch setting
DWI-15100-015-06	56 Volt Logic Supply	LEDs illuminated Correct input voltage Correct output voltage
DWI-15100-015-06	UPS (if required)	Setup per manufacturer's instructions
DWI-15100-015-06	Circuit Boards	Flash procedure
DWI-15100-015-06	Gate Drive Power Supplies	Calibrate per procedure
DWI-15100-015-06	Heat Sink Thermistors	Trips drive when pulled
DWI-15100-015-06	System Test Mode	External I/O Pressure Transducer
DWI-15100-015-06	Scaling Resistors	Calibrate
DWI-15100-015-06	Diagnostic Trend Buffer	Set-up
DWI-15100-015-06	I/O Checks	Function Test
DWI-15100-015-06	4-10 mA Transducers (if required)	Calibrate

DWI-15100-015-06	Ground Fault (If Zero Sequence CT is purchased)	Demonstrate trip function
DWI-15100-015-06	Control Power	Test DC Fail Circuit
DWI-15100-015-06	Test Mode 1	Check Rectifier Gating Check Inverter Gating
DWI-15100-015-06	Line Converter	With Rated Voltage applied check phase rotation and phase relationship
DWI-15100-015-06	Idc Test	With current circulating in the DC Link -check DC waveform for correct pattern & ripple -check AC waveform phase angle, notch depth and current balance -check flux feedback signal
DWI-15100-015-06	Machine Converter Test	Connected to Motor Load: -open loop stability -output waveforms at minimum speed -output phase relationship - adjust speed to 60 Hz, checking for normal noise & vibration - check machine converter voltage & current relationship
DWI-15100-015-06	Load Test	Connected to fully rated dynamometer load -1 hour rated load test - 1/2 hour torque step test

DET NORSKE VERITAS

MANAGEMENT SYSTEM CERTIFICATE

Certificate No. CERT-09379-2004-USA-RvA Rev. 1

This is to certify that

ROCKWELL AUTOMATION

at

1201 South 2nd Street, Milwaukee, WI 53204 USA (HQ)

has been found to conform to the Management System Standard:

ISO 9001:2008

This Certificate is valid for the following product or service ranges:

The Design, Manufacture, Re-Manufacture, Distribution, Support and Service of Automation Components and Systems.

Initial Certification date:
June 01, 1992

This Certificate is valid until:
May 17, 2013

The audit has been performed under the supervision of
Pat Jackson
Lead Auditor

MGMT. SYS. RvA C 024

Accredited by the RvA

Place and date:
Houston, Texas, March 10, 2011
for the Accredited Unit:
DNV CERTIFICATION B.V.,
THE NETHERLANDS

Rudy Frueboes
Management Representative

Lack of fulfillment of conditions as set out in the Certification Agreement may render this Certificate invalid.

DET NORSKE VERITAS

APPENDIX TO CERTIFICATE

This Appendix refers to Certificate No. CERT-09379-2004-USA-RvA Rev. 1

ROCKWELL AUTOMATION

locations included in the certification are as follows:

Site Name	Site Address	Site City	Site State/Country	Site Main Activities
Rockwell Automation	135 Dundas St.	Cambridge	Ontario Canada	Contracts, Design, Purchasing, Production, Warehousing
Rockwell Automation	2802 Bloomington Rd.	Champaign	IL USA	Contracts, Warehousing
Rockwell Automation	2 Executive Dr.	Chelmsford	MA USA	Contracts, Design
Rockwell Automation	10120 West 76th St., Ste. B	Eden Prairie	MN USA	Contracts, Design
Rockwell Automation	1506 East 16th St.	Ladysmith	WI USA	Production, Warehousing
Rockwell Automation	One Allen Bradley Dr.	Mayfield Heights	OH USA	Contracts, Design, Purchasing
Rockwell Automation	6680 Beta Drive	Mayfield Village	OH USA	Support , Service
Rockwell Automation	6400 W. Enterprise Dr.	Mequon	WI USA	Contracts, Design, Purchasing, Production, Warehousing, Remanufacturing
Rockwell Automation	1201 S. 2nd St.	Milwaukee	WI USA	Contracts, Purchasing, Design, Warehousing
Rockwell Automation	225 West 45th Ave.	Munster	IN USA	Repair, Remanufacturing
Rockwell Automation	Camino Vecinal No.3051	Nuevo Leon (Monterrey)	Mexico	Contracts, Design, Purchasing, Production, Warehousing
Rockwell Automation	1500 Peebles Dr.	Richland Center	WI USA	Contracts, Production, Warehousing
Rockwell Automation	Zona Franca De Las Americas, KM22 Las Americas Ave.	Santo Domingo	Dominican Republic	Contracts, Production, Warehousing
Rockwell Automation	100 Precision Dr.	Shirley	NY USA	Contracts, Design, Purchasing, Production, Repair, Warehousing
Rockwell Automation	Blvd. Encino 101 Parque Industrial	Tecate	Mexico	Contracts, Design, Purchasing, Production, Warehousing
Rockwell Automation	8440 Darrow Rd.	Twinsburg	OH USA	Design, Purchasing, Production, Remanufacture, Repair

Lack of fulfillment of conditions as set out in the Certification Agreement may render this Certificate invalid.